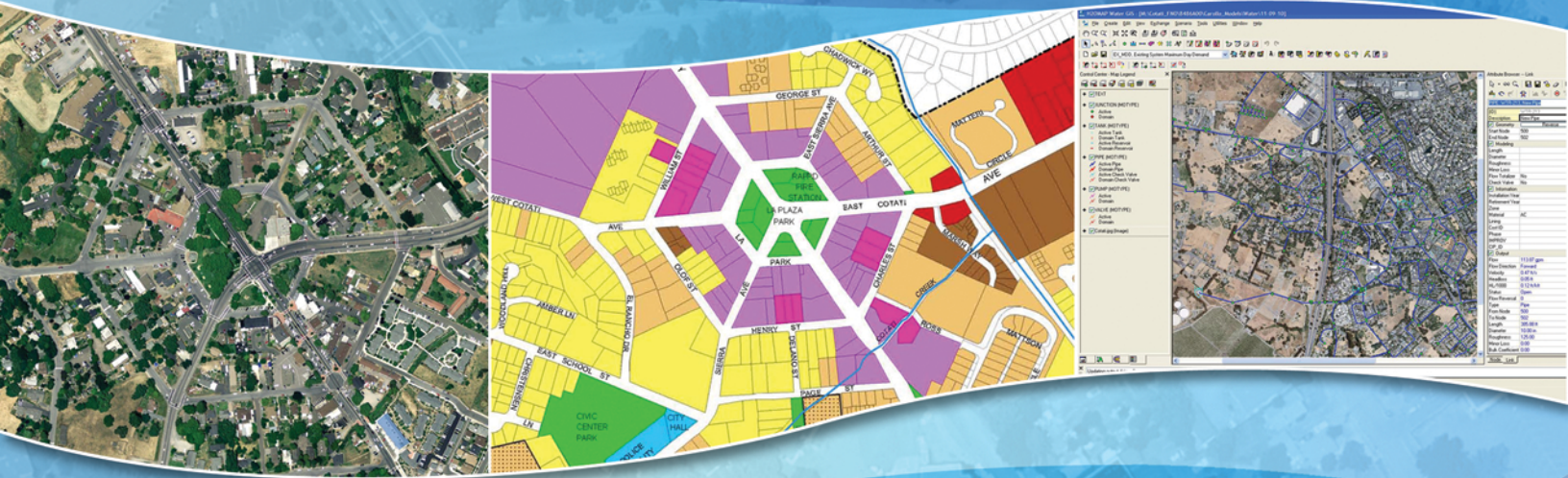


FINAL



Water Distribution System Master Plan

September 2011

carollo
Engineers...Working Wonders With Water®

September 6, 2011
8486A00

City of Cotati
201 West Sierra Avenue
City of Cotati, CA 94931

Attention: Mr. Damien O'Bid, P.E., City Engineer/Public Works Director

Subject: City of Cotati Final Water Distribution System Master Plan

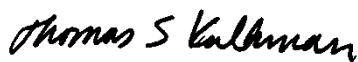
Dear Mr. O'Bid:

We are pleased to submit the final report for the City of Cotati (City) Water Distribution System Master Plan (WDSMP). Enclosed are three copies of the final WDSMP. This report summarizes work completed in Task 400 of the scope of work, including; hydraulic model development, water system evaluation, capital improvement plan (CIP) development, and master plan preparation.

We would like to extend our thanks to you, Mr. Kevin Fredrickson, Engineering Technician; Mr. Allan Martinoni, Field Maintenance Supervisor; Ms. Marsha Sue Lustig, Assistant to the City Manager/Acting Community Development Director; and other City staff whose courtesy and cooperation were valuable components in ensuring that this document will assist the City in planning infrastructure improvements to serve its customers.

Sincerely,

CAROLLO ENGINEERS, INC.



Thomas S. Kalkman, P.E.
Vice President



Tim J. Loper, P.E.
Project Manager

TSK/TJL:cjp



WATER DISTRIBUTION SYSTEM MASTER PLAN

Final

September 2011



September 1, 2011



September 1, 2011

Prepared By

Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598
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WATER DISTRIBUTION SYSTEM MASTER PLAN

TABLE OF CONTENTS

Page No.

EXECUTIVE SUMMARY - WATER DISTRIBUTION SYSTEM MASTER PLAN

ES.1	INTRODUCTION	ES-1
ES.2	STUDY AREA	ES-1
ES.3	HISTORICAL AND FUTURE POPULATION	ES-1
ES.4	WATER SERVICE AREA OVERVIEW	ES-3
ES.5	WATER DEMANDS.....	ES-3
ES.6	CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS	ES-5
	ES.6.1 Project Categories	ES-6
	ES.6.2 Existing Versus Future Improvement.....	ES-9
	ES.6.3 Well Improvements	ES-10
	ES.6.4 Tank Improvements	ES-10
	ES.6.5 Fire Flow Booster Pump/Rezoning Improvements	ES-10
	ES.6.6 Pipeline Improvements	ES-11
ES.7	CAPITAL IMPROVEMENT PLAN.....	ES-12

CHAPTER 1 - BACKGROUND

1.1	INTRODUCTION	1-1
1.2	BACKGROUND	1-1
1.3	WATER SERVICE AREA	1-1
1.4	SCOPE AND AUTHORIZATION	1-4
1.5	REPORT ORGANIZATION	1-4
1.6	ACKNOWLEDGMENTS	1-5
1.7	ABBREVIATIONS AND DEFINITIONS	1-5
1.8	REFERENCE MATERIAL.....	1-7

CHAPTER 2 - STUDY AREA DESCRIPTION

2.1	STUDY AREA	2-1
2.2	PLANNING PERIOD.....	2-1
2.3	CLIMATE.....	2-1
2.4	LAND USE	2-1
2.5	HISTORICAL AND FUTURE POPULATION	2-5

CHAPTER 3 - PLANNING CRITERIA

3.1	WATER DISTRIBUTION SYSTEM	3-1
3.1.1	Water Supply Capacity	3-1
3.1.1.1	Firm Supply Capacity.....	3-1
3.1.2	Storage Requirements.....	3-1
3.1.2.1	Operational Equalization Storage.....	3-2
3.1.2.2	Fire Storage	3-2
3.1.2.3	Emergency Storage	3-2
3.1.2.4	Total Storage	3-3
3.1.3	Service Pressures.....	3-3

3.1.4	Distribution Mains.....	3-4
3.1.4.1	Velocities During Normal Conditions.....	3-4
3.1.4.2	Velocity During Fire Flow Conditions	3-4
3.1.5	Fire Flows.....	3-5

CHAPTER 4 - WATER DEMAND

4.1	HISTORICAL WATER USE.....	4-1
4.1.1	Historical Production and Consumption	4-1
4.1.2	Per Capita Water Use	4-3
4.1.3	Seasonal Demands and Peaking Factors	4-3
4.1.3.1	Average Day Demand (ADD)	4-4
4.1.3.2	Maximum Month Demand (MMD)	4-4
4.1.3.3	Maximum Day Demand (MDD)	4-4
4.1.3.4	Peak Hour Demand (PHD)	4-4
4.2	EXISTING AND PROJECTED WATER DEMAND	4-5
4.2.1	Existing and Future Water Demand Coefficients	4-5
4.2.2	Future Water Demands	4-5
4.3	PLANNING CRITERIA SUMMARY	4-7

CHAPTER 5 - DISTRIBUTION SYSTEM FACILITIES AND HYDRAULIC MODEL

5.1	WATER DISTRIBUTION SYSTEM OVERVIEW	5-1
5.1.1	Distribution System	5-1
5.1.2	Pressure Zones.....	5-1
5.1.3	Groundwater Wells	5-4
5.1.4	SCWA Turnouts.....	5-5
5.1.5	Storage Tanks.....	5-5
5.2	WATER SYSTEM HYDRAULIC MODEL	5-6
5.2.1	Previous Hydraulic Computer Model	5-6
5.2.2	Selected Hydraulic Model	5-6
5.2.3	Elements of the Hydraulic Model	5-7
5.2.4	Hydraulic Model Construction	5-8
5.3	HYDRAULIC MODEL CALIBRATION	5-9
5.3.1	Macro Calibration	5-9
5.3.2	Fire Flow Field Testing.....	5-9
5.3.2.1	Fireflow Calibration Results.....	5-12

CHAPTER 6 - CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

6.1	SUPPLY ANALYSIS	6-1
6.2	STORAGE ANALYSIS.....	6-1
6.3	DISTRIBUTION SYSTEM ANALYSIS	6-4
6.3.1	System Pressure Analysis	6-4
6.3.1.1	Existing System	6-4
6.3.1.2	Future System	6-11
6.3.2	Pipeline Velocity Analysis	6-11
6.3.2.1	Existing System	6-11
6.3.2.2	Future System	6-12
6.4	DISTRIBUTION SYSTEM IMPROVEMENTS	6-12
6.4.1	Project Categories	6-16
6.4.2	Existing Versus Future Improvement.....	6-17
6.4.3	Well Improvements	6-17

6.4.4	Tank Improvements	6-17
6.4.5	Fire Flow Booster Pump/Rezoning Improvements	6-18
6.4.6	Pipeline Improvements	6-18

CHAPTER 7 - CAPITAL IMPROVEMENT PLAN

7.1	CAPITAL IMPROVEMENT PROJECT COSTS	7-1
7.2	COST ESTIMATING ACCURACY.....	7-1
7.3	CONSTRUCTION UNIT COSTS.....	7-1
7.3.1	Pipeline Unit Costs.....	7-1
7.3.2	Storage Tank, Booster Pumps, and Well Costs.....	7-2
7.4	PROJECT COSTS AND CONTINGENCIES.....	7-3
7.4.1	Baseline Construction Cost	7-3
7.4.2	Estimated Construction Cost	7-3
7.4.3	Capital Improvement Cost	7-3
7.5	CAPITAL IMPROVEMENT IMPLEMENTATION.....	7-4
7.6	EXISTING VERSUS FUTURE USER COST SHARE.....	7-6

APPENDIX A	2010 UWMP Water Demand Analysis and Water Conservation Measures Update
APPENDIX B	Groundwater Well Information
APPENDIX C	Fire Flow Calibration Details

LIST OF TABLES

Table ES.1	Historical and Projected Population.....	ES-3
Table ES.2	Water Use Demand Summary.....	ES-5
Table ES.3	Summary of Capital Costs by Improvement Category	ES-12
Table ES.4	Existing Versus Future User Cost Share.....	ES-13
Table ES.5	Existing Versus Future User Cost Share by Facility Type.....	ES-13
Table 2.1	Study Area Zoning Designations	2-3
Table 2.2	Historical and Projected Population.....	2-6
Table 3.1	Pipe Roughness.....	3-5
Table 4.1	Historical Water Production and Consumption	4-2
Table 4.2	Water Demand Coefficients and Projected ADD	4-6
Table 4.3	Water Use Demand Summary.....	4-7
Table 4.4	Planning Criteria Summary	4-8
Table 5.1	Water Distribution System Pipeline Summary.....	5-1
Table 5.2	Groundwater Well Summary.....	5-4
Table 5.3	Summary of Turnouts from SCWA	5-5
Table 5.4	Storage Tank Summary	5-6
Table 5.5	Fire Test Calibration Results	5-13
Table 6.1	Water Supply Analysis - Largest Supply Source Out of Service.....	6-2
Table 6.2	Storage Capacity Analysis	6-5
Table 6.3	Proposed Water Distribution System Improvements	6-15

Table 7.1	Pipeline Construction Unit Costs	7-2
Table 7.2	Facility Construction Unit Costs	7-2
Table 7.3	Capital Improvement Plan.....	7-5
Table 7.4	Summary of Capital Costs by Improvement Category	7-6
Table 7.5	Existing Versus Future User Cost Share.....	7-7
Table 7.6	Existing Versus Future User Cost Share by Facility Type.....	7-7

LIST OF FIGURES

Figure ES.1	Study Area.....	ES-2
Figure ES.2	Existing Water Distribution System.....	ES-4
Figure ES.3	Proposed Capital Improvements	ES-7
Figure ES.4	Proposed Improvements to Create New Boosted Fire Zone	ES-8
Figure 1.1	Location Map.....	1-2
Figure 1.2	Current Water Service Area.....	1-3
Figure 2.1	Study Area.....	2-2
Figure 2.2	Cotati Zoning Map.....	2-4
Figure 2.3	Historical and Projected Population.....	2-6
Figure 4.1	Historical Production by Source (1995 - 2009).....	4-3
Figure 5.1	Existing Water Distribution System.....	5-2
Figure 5.2	Hydraulic Profile of the Water Distribution System.....	5-3
Figure 5.3	Hydrant Test Locations	5-11
Figure 6.1	Increase in Supply and Demand.....	6-3
Figure 6.2	Required Storage Capacity.....	6-6
Figure 6.3	Existing System MDD Analysis	6-8
Figure 6.4	Existing System PHD Analysis	6-9
Figure 6.5	Existing System MDD + Fire Flow Analysis.....	6-10
Figure 6.6	Proposed Capital Improvements	6-13
Figure 6.7	Proposed Improvements to Create New Boosted Fire Zone	6-14

WATER DISTRIBUTION SYSTEM MASTER PLAN

ES.1 INTRODUCTION

The City of Cotati (City) is located in Sonoma County, about 45 miles north of San Francisco in the 101 corridor between Rohnert Park and Petaluma. Cotati has long been considered the "Hub" of Sonoma County by virtue of its central location and its distinct and historic hexagonal plaza. The City's residents enjoy the benefits of living in a small city, as well as the cultural advantages of being located near major urban centers¹.

The City owns, maintains, and operates distribution system pipelines, wells, and storage tanks within its service area. The City distributes water to residential and commercial customers. The City also has two turnouts from the Sonoma County Water Agency (SCWA).

ES.2 STUDY AREA

According to City staff, growth within the next 25 years is primarily expected to occur within the current City limits. Therefore, the study area boundary for this Water Distribution System Master Plan (Master Plan) and the current City limits are coterminous and will be used interchangeably throughout the Master Plan report. Figure ES.1 shows the study area boundary, which is roughly bounded by the City of Rohnert Park to the north and east and unincorporated areas of Sonoma County to the south and west.

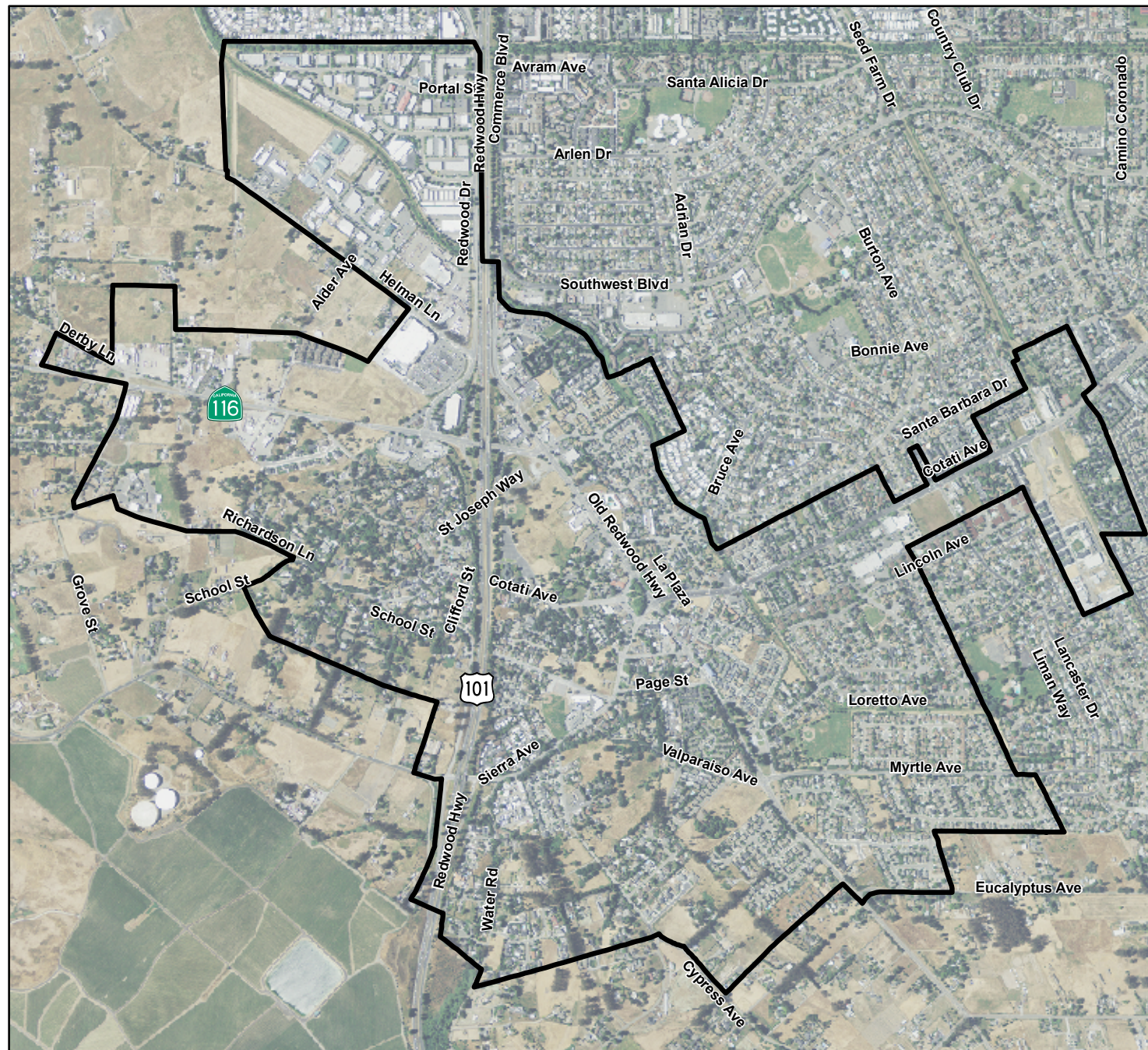
The City's current General Plan was adopted in 1998. The City is currently in the process of updating the General Plan. According to City staff, the land use assumptions that will be incorporated into the General Plan Update will be based on the City's current zoning map. For this reason, the land use assumptions used in this Master Plan are consistent with the City's current zoning designations.

The City is not anticipating that it will annex any additional land areas beyond the current City limits within the planning period of this Master Plan. For this reason, land use assumptions in this study do not extend beyond the current City limits.

ES.3 HISTORICAL AND FUTURE POPULATION

According to California Department of Finance (DOF) population estimates, between 1970 and 2005, the City's population grew by roughly 5,816 residents, from 1,368 in 1970, to 7,184 residents in 2005. Over these 35 years, that growth equated to an average annual rate of approximately 4.9 percent.

¹ <http://www.ci.cotati.ca.us/>



Legend

City Limits



0 1,000 2,000 Feet

Figure ES.1
Study Area
 Water Distribution System
 Master Plan
 City of Cotati



Population projections used in this Master Plan are based on forecasts provided in the City's Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update, dated November 2010 (Maddaus Report). The population forecasts presented in the Maddaus Report project that the City will reach a population of approximately 9,889 people by 2035. Table ES.1 summarizes the City's historical and projected population to year 2035.

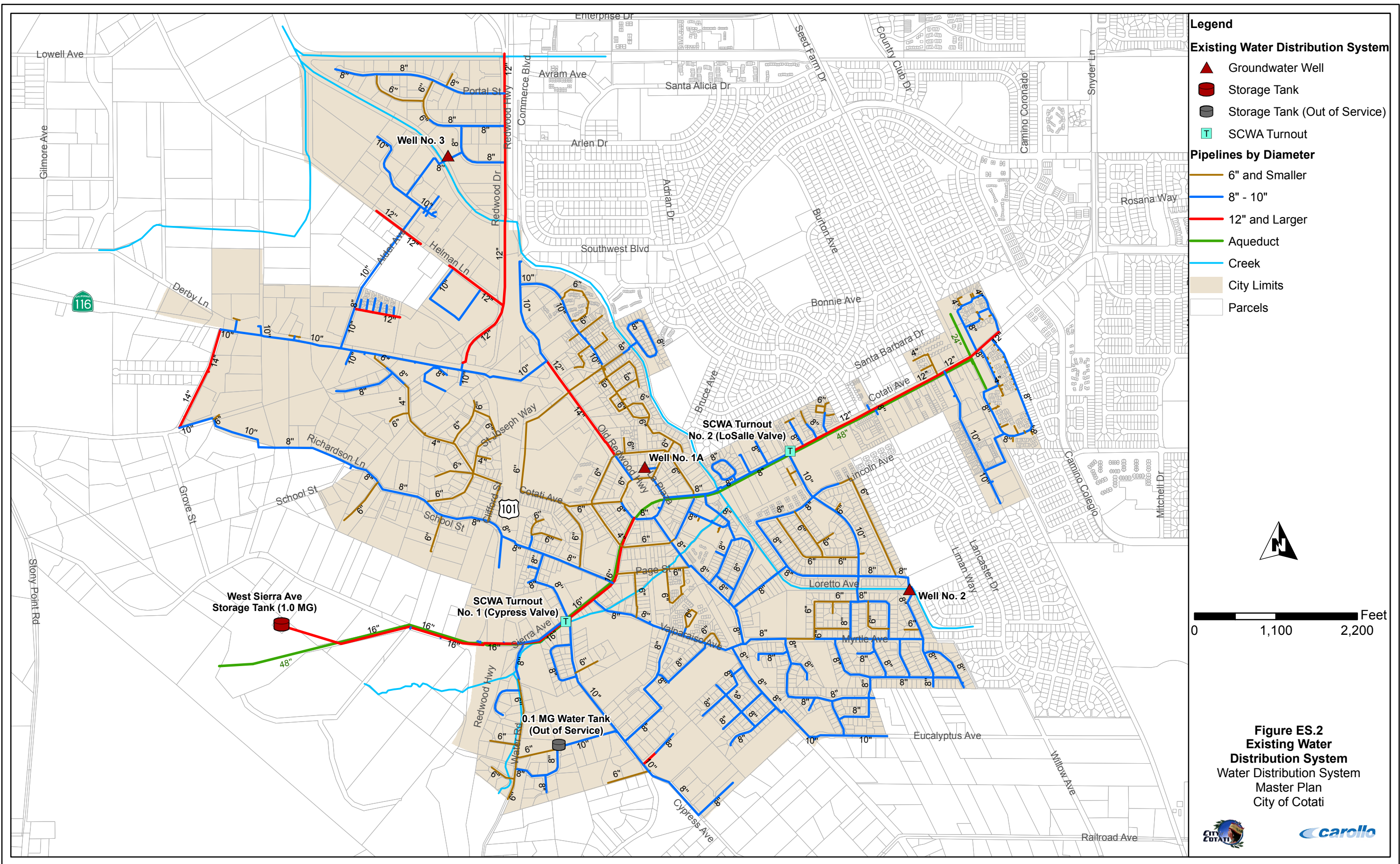
Table ES.1 Historical and Projected Population Water Distribution System Master Plan City of Cotati			
Year	Population ^{(1),(2)}	Year	Population ^{(1),(2)}
1970	1,368	2005	7,184
1975	2,870	2010	7,711
1980	3,346	2015	8,105
1985	4,030	2020	8,518
1990	5,625	2025	8,953
1995	6,332	2030	9,409
2000	6,480	2035	9,889
Notes: 1. Historical population based on California Department of Finance estimates for the City of Cotati. 2. Population projections provided in the City of Cotati Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update, November 2010.			

ES.4 WATER SERVICE AREA OVERVIEW

The City's water supply system consists of two turnouts from SCWA, as well as three groundwater wells. Water is transmitted from the City's supply sources to the consumers via a system of approximately 30 miles of active distribution system pipeline with sizes ranging from 4- to 16-inches in diameter. The City's distribution system also includes two storage tanks, one of which is currently out of service. Figure ES.2 shows the City's current water distribution system, including pipe diameters, as well as groundwater wells, SCWA turnouts, and storage tank locations.

ES.5 WATER DEMANDS

The average day demand (ADD) is the total annual production divided by number of days in the year. For example, in 2000, the ADD was approximately 1.10 million gallons per day (mgd), and in 2009, the ADD was 0.90 mgd.



The maximum month demand (MMD) is the average daily demand for the month with the highest production during the year, usually occurring in the summer. For Cotati, the average ratio of MMD to ADD from 1995 to 2009 was 1.6, which based on Carollo's experience on previous projects, is in the range of typical values.

The maximum day demand (MDD) is the greatest water demand during a 24-hour period of the year. In general, the MDD is 2.0 to 2.5 times greater than the ADD. Daily production data was not available from the SCWA turnouts to determine the MDD, so a MDD peaking factor was calculated based on guidelines from the California Department of Public Health's (CDPH's) revised Waterworks Standards. The CDPH recommends a MDD to MMD peaking factor of at least 1.5, which equates to 2.4 times the ADD in the case of the City.

The peak hour demand (PHD) is the highest water demand during any one-hour period of the year. A normal day typically experiences two peak demands, in the morning and then evening. In general, the PHD ranges between 2.5 and 3.5 times greater than the ADD. Hourly demands were not available for this project, so a PHD peaking factor was calculated based on guidelines from the CDPH Waterworks Standards. The CDPH recommends a PHD to MDD peaking factor of at least 1.5, which equates to 3.6 times the ADD.

A summary of the existing and future ADD is presented in Table ES.2. In addition to the projected average demands, Table ES.2 includes estimates for the MDD and PHD through year 2035. Based on these projections, it is anticipated that the City's year 2035 ADD, MDD, and PHD will approach 1.34 mgd, 3.22 mgd, and 4.83 mgd, respectively.

Table ES.2 Water Use Demand Summary Water Distribution System Master Plan City of Cotati			
Year	Average Day Demand (mgd)	Maximum Day Demand (mgd)	Peak Hour Demand (mgd)
Existing (2010)	0.98	2.36	3.54
Build-Out (2035)	1.34	3.22	4.83

ES.6 CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

The capacity analysis of the City's water distribution system consisted of the following:

- **Supply Analysis.** The water supply requirements for the City under existing and future demand conditions were determined by comparing the available water supplies with the projected water demands. This study recommends that the City maintain a firm water supply capacity equal to the MDD. According to Department of Public Health Standards, firm capacity is equal to total capacity of the City's groundwater and surface water supplies, minus the capacity of the largest water source. According

the Restructured Agreement for Water Supply between the City and SCWA, the maximum amount of water that can be delivered to the City totals 3.8 mgd. Therefore, the largest single supply source through year 2035 will be the SCWA water supply (3.8 mgd).

- **Storage Analysis.** The purpose of storage is to provide the City with operational equalization storage to meet PHDs, fire flow storage, and emergency storage. Based on recommendations from the American Water Works Association's Manual of Water Supply Practices M32, the storage criteria used in this study consist of: Operational equalization storage at 25 percent of the MDD; Fire flow storage of 2,500 gallons per minute (gpm) fire flow for two hours; and Emergency storage at 100 percent of the ADD. The required storage through year 2035 was calculated based on the projected ADD and MDD. The required storage was then compared to the City's current available storage capacity to determine the need for additional storage tanks. Water age was not reviewed as part of this Master Plan.
- **Distribution System Analysis.** The distribution system analysis consisted of system pressure analysis, fire flow analysis, and pipeline velocity analysis for the City's water distribution system under both existing and future conditions based on the evaluation criteria defined in Chapter 3. Improvement projects were identified in order to mitigate system deficiencies and to serve future growth.

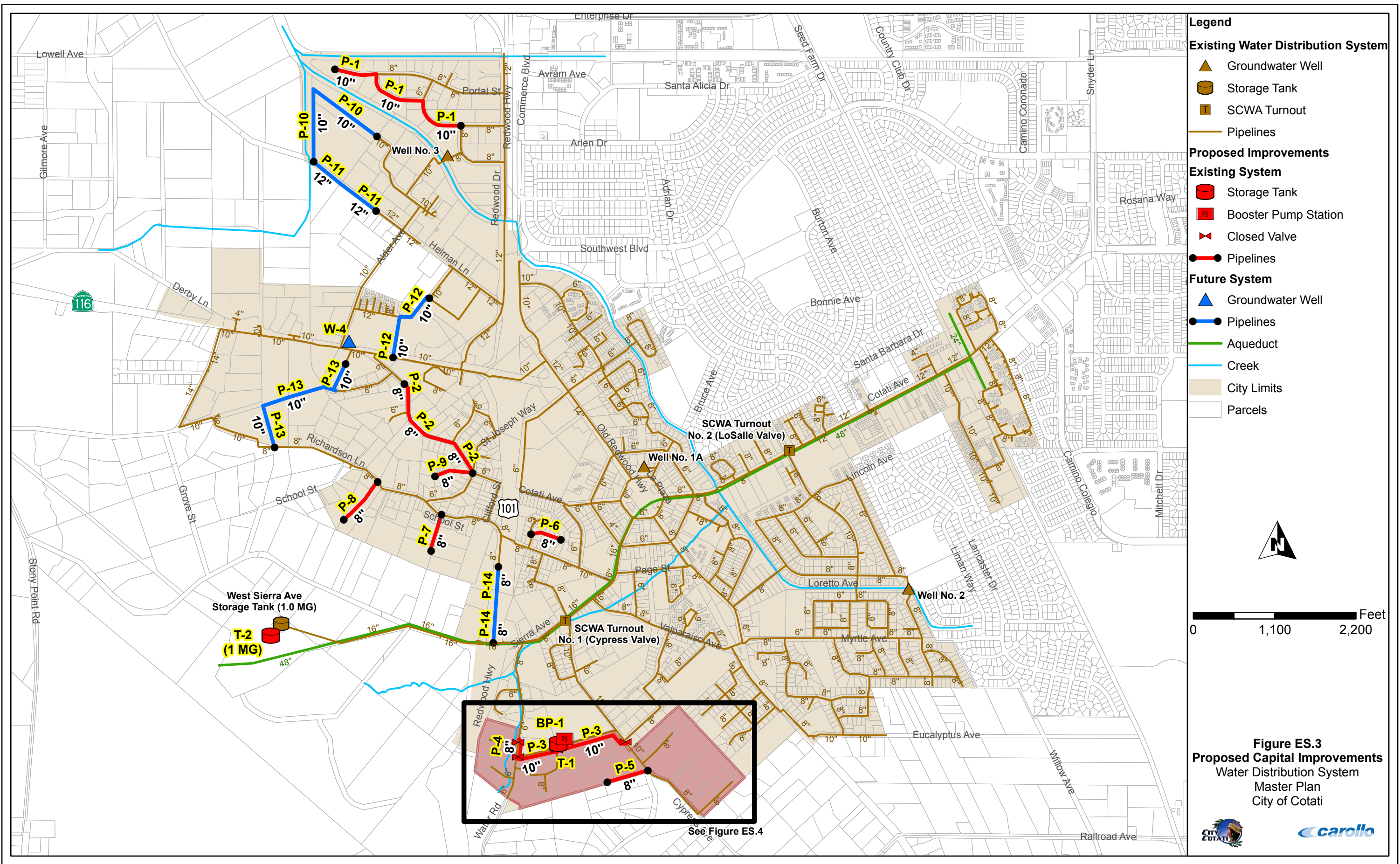
Figure ES.3 illustrates the improvements recommended to mitigate capacity deficiencies in the existing water system and the improvements to meet future demand as identified by the hydraulic analysis. A detail map for the proposed improvements in the vicinity of the Cypress tank are provided in Figure ES.4 for clarity.

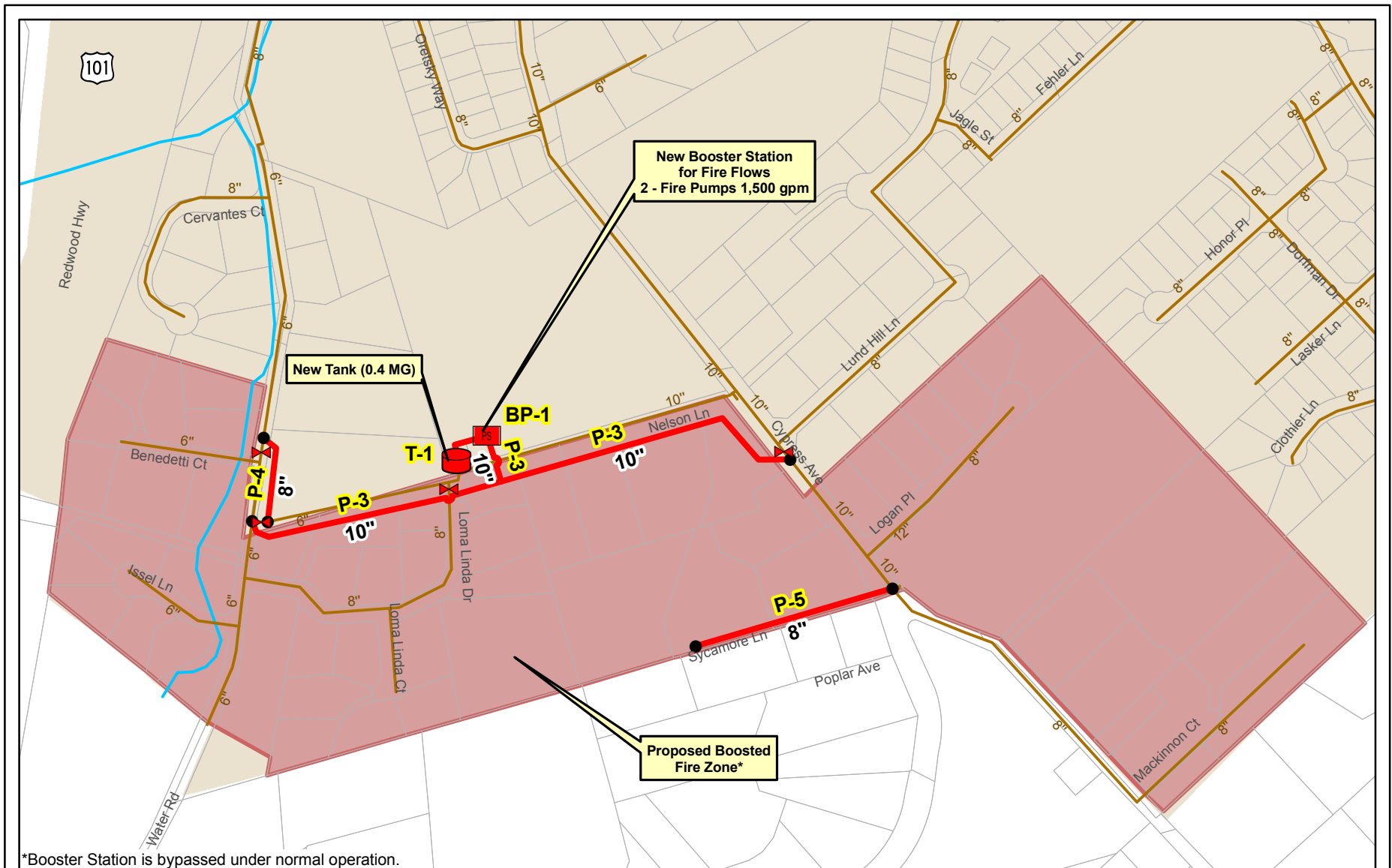
ES.6.1 Project Categories

The proposed projects provide the City with a list of improvements that will correct capacity deficiencies in the distribution system that could occur during peak demand conditions or during a fire flow events. When fully implemented, the capital projects will enhance the distribution of water during maximum demand conditions to existing and future users.

Each improvement project shown on Figure ES.3 was grouped into one of four different categories, based on the type of deficiency that is meant to be addressed by the improvement. The four categories are discussed below:

- **Category 1: Supply/Storage Improvements to Meet CDPH Standards.** Proposed supply and storage improvements that are primarily needed to meet the CDPH standards were grouped into Category 1. These improvements also benefit the City's ability to provide needed fire flow throughout the City. The predominant driving factor behind these improvements, however, is meeting the CDPH standards for supply and storage.





Legend

Existing Water Distribution System

Pipelines

Proposed Improvements

Existing System

Storage Tank

Booster Pump Station

Valves to Close

Pipelines

New Boosted Fire Zone

Creek

Parcels

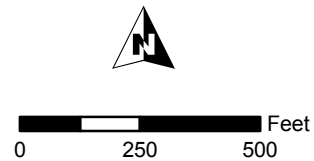


Figure ES.4
Proposed Improvement Projects to Create
New Boosted Fire Zone
Water Distribution System Master Plan
City of Cotati



- **Category 2: Network Improvements to Provide Needed Fire Flow.** Pipeline and booster pump station improvements required to provide the needed fire flow within the main distribution system network were grouped into Category 2. The improvements generally address fire flow deficiencies in large blocks of the City (e.g., not at a single hydrant on a dead end main).
- **Category 3: Dead End Pipe Improvements to Provide Needed Fire Flow and to Meet AWWA Standards.** The City's water distribution system includes dead end pipelines to service individual cul-de-sacs and residences in the City. Many of these pipelines are 6-inches in diameter and smaller, and are not adequately sized to provide the needed fire flow at hydrant locations on the dead end mains. The American Waterworks Association (AWWA) Manual M31 provides minimum standards for dead end piping with hydrants. According to Manual M31, dead end piping should have a minimum diameter of 8-inches.

Category 3 improvements are defined as pipeline improvements that are required to provide the needed fire flow in dead end water mains 6-inches in diameter and smaller. It should be noted that the Category 3 improvements include only dead end mains that cannot provide the needed fire flow. Recognizing that it is impractical to replace all dead end 6-inch diameter mains, dead end mains that can provide the needed fire flow were not targeted for replacement as part of this study.
- **Category 4: Improvements to Provide Main Looping in Future Development Areas.** System improvements exclusively required to provide distribution system looping in vacant areas within the City limits were targeted as Category 4 improvements.

ES.6.2 Existing Versus Future Improvement

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to meet fire flow criteria) for existing users. If a project was proposed to exclusively correct an existing deficiency, then existing users were assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.

Future growth will trigger the construction of new facilities to support this growth (e.g., new distribution system pipelines to serve vacant areas within the City service area). If a specific project is needed to serve future growth exclusively, the future users were assigned 100 percent of the future project's benefit and 100 percent of the costs.

In some cases, such as a proposed storage tank, projects are needed to mitigate existing deficiencies and to accommodate future growth. Where a project is needed to mitigate existing deficiencies and serve future growth, the future user benefit was determined based on the additional capacity necessary to serve future growth. More information on the breakdown in cost split between existing and future users and whether a proposed

improvement is intended to correct an existing deficiency, to serve a future user, or both is provided in Chapter 7.

ES.6.3 Well Improvements

The supply capacity analysis indicated that the City's existing firm supply capacity is approximately 2.07 mgd, compared to an existing MDD of roughly 2.36 mgd. Therefore, the City's existing MDD is very close to the existing firm capacity. Since the existing firm capacity is very close to the MDD, additional supply sources will be needed to serve future demands generated by development. It is recommended that the City construct one additional groundwater well to accommodate future growth. Based on the supply capacity analysis, it is recommended that the City install future Well 4 (Improvement Number W-4), with a capacity of roughly 870 gpm (1.25 mgd). This is a Category 1 improvement. With the installation of Well 4, the City will have enough firm capacity to provide supply through build out (year 2035).

ES.6.4 Tank Improvements

The storage capacity analysis indicated that the City currently has a storage deficiency of 0.87 million gallons (MG). Therefore, additional storage tanks are recommended. The City is planning to construct a new 400,000 gallon storage tank at the site of the existing inactive Cypress Tank (Improvement Number T-1). This is a Category 1 improvement. Construction of this tank would decrease the existing storage capacity deficit to roughly 0.47 MG.

To fully mitigate the existing storage deficiency and to service future growth, it is recommended that an additional, 1.0 MG tank be constructed. For budgeting purposes, this Master Plan assumes that the new 1.0 MG tank (Improvement Number T-2) will be constructed adjacent to the existing West Sierra Tank site. This is also a Category 1 improvement.

ES.6.5 Fire Flow Booster Pump/Rezoning Improvements

In order to provide adequate service pressures and to meet the required fire flows in the vicinity of the inactive Cypress Tank, it is recommended that the City create a new boosted fire zone to serve this area. The new boosted fire zone would be configured in a manner shown on Figure ES.4. The new pressure zone would require the installation of a new booster pump station (Improvement No. BP-1) adjacent to the proposed 400,000 gallon Cypress Tank (Improvement No. T-1). The new Cypress Booster Pump Station would consist of two 1,500 gpm fire pumps to provide the required fire flow while meeting the minimum 20 pounds per square inch (psi) residual requirement.

The Cypress Booster Pump Station will pump water from the new 400,000-gallon Cypress Tank into the boosted pressure zone. Additional pipelines are also recommended (Improvement Numbers P-3 and P-4) to create loops in both the City's main pressure zone

and the new boosted fire zone. Figure ES.4 also shows the locations of valves to close in order to isolate the proposed boosted zone from the City's main pressure zone.

Under normal operating conditions, the Cypress Booster Pump Station will remain inactive and water will be allowed to bypass the pump station via a bypass pipeline and valve at the pump station. The three valves shown on Figure ES.4 would remain closed under all operating conditions. During a fire flow, the bypass valve at the booster pump station would close (isolating the boosted fire zone from the City's main pressure zone) and one (or more if necessary) of the fire pumps would turn on to provide the needed fire flow. In essence, system pressures in the new zone will be essentially unchanged from the existing configuration under normal operating conditions. The only time that the new zone would be "boosted" would be under fire flow conditions.

The fire flow booster pump station/rezoning improvements are Category 2 improvements.

ES.6.6 Pipeline Improvements

Based on the results of the existing and future system pressure and pipeline velocity analysis, the following projects are recommended:

- **Existing System Improvements**
 - Improvement Number P-1: It is recommended that the City replace the existing 6-inch and 8-inch diameter water main on Aaron Street, Mercantile Drive, and Portal Street with a 10-inch diameter water main in order to meet the required 2,500 gpm fire flow for this industrial zoning area. This is a Category 2 improvement.
 - Improvement Number P-2: To meet the required 1,500 gpm fire flow for the area near West Cotati Avenue west of Highway 101 and South of Highway 116, it is recommended that the existing 4-inch diameter water main on West Cotati Avenue from Maple Avenue to west of Cohen Court be replaced with a new 8-inch diameter water main. This is a Category 2 improvement.
 - Improvement Number P-3 and P-4: Construct a new 10-inch diameter and 8-inch diameter water mains near the proposed 400,000 gallon Cypress Tank (Improvement Number T-1) to create a new boosted fire zone as described in Section ES.6.5 (Improvement Number BP-1). These pipelines are grouped as Category 2 improvements.
 - Improvement Number P-5 through P-9: Replace various dead end 6-inch diameter water mains throughout the City with 8-inch diameter water mains to meet the required fire flow criteria. These are Category 3 improvements.

- **Future System Improvements**
 - Improvement Number P-10 through P-14: Construct various 8-inch, 10-inch, and 12-inch diameter water mains to connect loops within currently undeveloped areas within the City. These are Category 4 improvements.

ES.7 CAPITAL IMPROVEMENT PLAN

A summary of the capital project costs is presented in Chapter 7 of the Master Plan. Chapter 7 provides detailed information related to the projects, a description of the project, identifies facility size, the capital improvement cost, and the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

The implementation phases are separated into 5-year increments. Each project is itemized by phase in Chapter 7 and a summary by improvement category and phase is provided in Table ES.3. Category 1 improvements totaled nearly 5 million of the total 7.32 million due to needed supply and storage upgrades. The remaining categories ranged from 0.41 million to 1.18 million of the total cost. Categories 1-3 should be implemented during the first two phases showing the immediate need and category 4 should be implemented during the remaining phases for future developments.

Table ES.3 Summary of Capital Costs by Improvement Category Water Distribution System Master Plan City of Cotati						
Improvement Category	Implementation Phase					Total (\$, mill.)
	2011-16 (\$, mill.)	2017-21 (\$, mill.)	2022-26 (\$, mill.)	2027 - 31 (\$, mill.)	2032 - 36 (\$, mill.)	
Category 1 ⁽¹⁾	2.50	2.19	0.00	0.00	0.00	4.70
Category 2 ⁽²⁾	1.00	0.03	0.00	0.00	0.00	1.03
Category 3 ⁽³⁾	0.00	0.41	0.00	0.00	0.00	0.41
Category 4 ⁽⁵⁾	0.00	0.00	0.45	0.58	0.15	1.18
Total	3.51	2.63	0.45	0.58	0.15	7.32
Notes:						
1. Category 1 projects are supply/storage improvements to meet CDPH standards.						
2. Category 2 projects are mainline improvements to provide needed fire flow.						
3. Category 3 projects are dead end pipeline replacements to provide needed fire flow and to meet AWWA Manual M31 standards.						
4. Category 4 projects provide looping in future development areas.						
5. Costs are based on ENR CCI 20 City average of 8,998 (February 2011).						

An opinion of benefit to future users, based on preliminary project information, is included in Table ES.4. Additionally, costs are broken down for existing and future user cost share of the proposed projects by facility categories (e.g. pipelines, wells, etc.). Existing users will

share the cost of 1.44 million of pipeline improvements, 1.91 million for tanks, and 0.8 million for booster pumps. Future users will share the cost associated with 1.18 million worth of pipeline improvements, 0.81 for new wells, 1.16 for supply tanks, and 0.02 for a booster pump station. The cost breakdown for existing and future users is summarized in Table ES.5.

Table ES.4 Existing Versus Future User Cost Share Water Distribution System Master Plan City of Cotati						
Reimbursement Category	Implementation Phase					Total (\$, mill.)
	2011-16 (\$, mill.)	2017-21 (\$, mill.)	2022-26 (\$, mill.)	2027 - 31 (\$, mill.)	2032 - 36 (\$, mill.)	
Existing User ⁽²⁾	2.68	1.47	0.00	0.00	0.00	4.14
Future User ⁽³⁾	0.83	1.16	0.45	0.58	0.15	3.17
Total	3.51	2.63	0.45	0.58	0.15	7.32
Notes:						
1. Costs are based on ENR CCI 20 City average of 8,998 (February 2011).						
2. Projects are funded through user rates.						
3. Projects are expected to be funded through water development impact fees collected by the City through new connections.						

Table ES.5 Existing Versus Future User Cost Share by Facility Type Water Distribution System Master Plan City of Cotati					
Reimbursement Category	Facility Type				Total (\$, mill.)
	Pipelines (\$, mill.)	Wells (\$, mill.)	Tanks (\$, mill.)	Booster Pumps (\$, mill.)	
Existing User ⁽²⁾	1.44	0.00	1.91	0.80	4.14
Future User ⁽³⁾	1.18	0.81	1.16	0.02	3.17
Total	2.62	0.81	3.07	0.81	7.32
Notes:					
1. Costs are based on ENR CCI 20 City average of 8,998 (February 2011).					
2. Projects are funded through user rates.					
3. Projects are expected to be funded through water development impact fees collected by the City through new connections.					

BACKGROUND**1.1 INTRODUCTION**

This chapter presents a brief summary of the water distribution system service area, the need for this Water Distribution System Master Plan (Master Plan) and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

1.2 BACKGROUND

The City of Cotati (City) is located in Sonoma County, about 45 miles north of San Francisco in the 101 corridor between Rohnert Park and Petaluma. Figure 1.1 shows the location of the City relative to other metropolitan areas in northern California. Cotati has long been considered the "Hub" of Sonoma County by virtue of its central location and its distinct and historic hexagonal plaza. The City's residents enjoy the benefits of living in a small city, as well as the cultural advantages of being located near major urban centers¹.

The City owns, maintains and operates the distribution system pipelines, wells, and storage tanks within its service area. The City distributes water to residential and commercial customers. The City also receives water from two Sonoma County Water Agency (SCWA) turnouts.

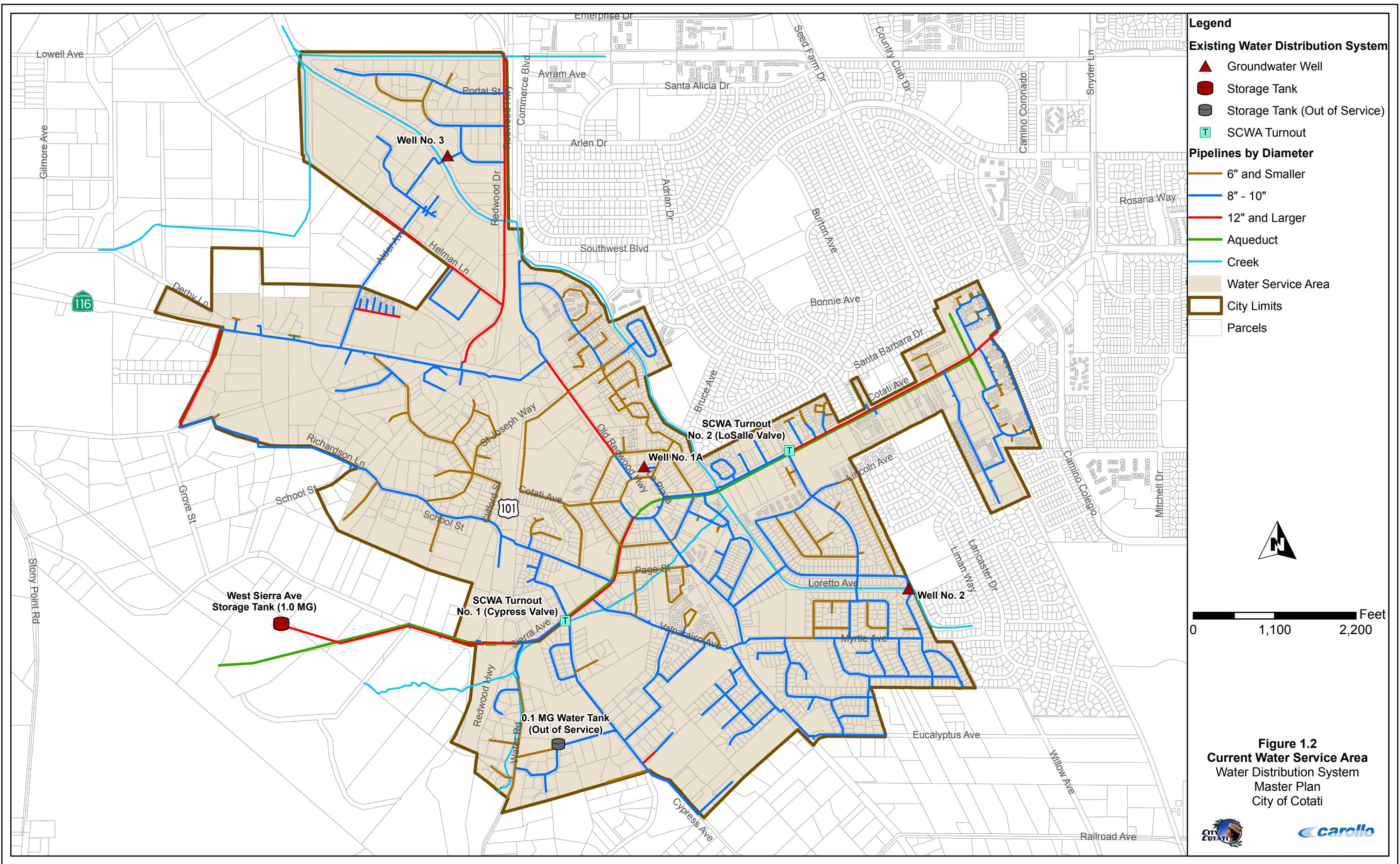
1.3 WATER SERVICE AREA

Figure 1.2 illustrates the City's current water distribution system service area. The City manages and maintains approximately 30 miles of distribution pipelines ranging from 4- to 16-inches in diameter, three groundwater wells, two SCWA turnout connections and two storage tanks. In addition to these major facilities, the City also maintains hundreds of water valves and hydrants throughout its distribution system.

The City's zoning designations set the foundation for the land use assumptions in this Master Plan. Should future planning conditions change from the assumptions stated in this Master Plan (i.e., accelerated growth, more intense developments, etc.), revisions and adjustments to the Master Plan recommendations may be necessary.

¹ <http://www.ci.cotati.ca.us/>





1.4 SCOPE AND AUTHORIZATION

The purpose of this Master Plan is to identify capacity deficiencies in the water distribution system, develop feasible alternatives to correct identified deficiencies, and plan the infrastructure that will serve future development. In May 2010, the City approved a professional service agreement with Carollo Engineers, Inc. (Carollo), formerly Carollo Engineers, P.C., to prepare this Master Plan for the water distribution system, which included the following main tasks:

- Hydraulic model development
- Water system evaluation
- Capital Improvement Plan (CIP) development
- Master Plan preparation

1.5 REPORT ORGANIZATION

The Master Plan report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 - Background. This chapter presents the need for this Master Plan and the objectives of the study. Lists of abbreviations and reference materials are also provided to assist the reader in understanding the information presented.

Chapter 2 - Study Area Description. This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.

Chapter 3 - Planning Criteria. This chapter presents the planning criteria for evaluating the water distribution system. The planning criteria address the distribution system capacity, minimum pressure, maximum velocity and head loss, supply and storage requirements, average water demand coefficients, and peaking factors.

Chapter 4 - Water Demand. This chapter presents the calculation of the water demands used to model the existing and future distribution system.

Chapter 5 - Distribution System Facilities and Hydraulic Model. This chapter describes the development and calibration of the City's water distribution system hydraulic model.

Chapter 6 - Capacity Evaluation and Proposed Improvements. This chapter discusses the hydraulic evaluation of the distribution system and the proposed projects that correct deficiencies and serve future users.

Chapter 7 - Capital Improvement Plan. This chapter presents the capital improvement plan, a summary of the capital costs, and assessment of the costs that the City will need to recover from existing and future users. This chapter is organized to assist the City in making finance decisions.

1.6 ACKNOWLEDGMENTS

Carollo Engineers wishes to acknowledge and thank Mr. Damien O'Bid, City Engineer/Director of Public Works; Kevin Fredrickson, Engineering Technician; Allan Martinoni, Field Maintenance Supervisor; and Marsha Sue Lustig, Assistant to the City Manager/Acting Community Development Director. Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report.

1.7 ABBREVIATIONS AND DEFINITIONS

To conserve space and to improve readability, the following abbreviations are used in this report.

AACE	Association for the Advancement of Cost Engineering
ADD	Average Day Demand
AWWA	American Waterworks Association
Carollo	Carollo Engineers, Inc.
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CIP	Capital Improvement Plan
City	City of Cotati
DOF	California Department of Finance
ENR CCI	Engineering News Record Construction Cost Index
EPA	Environmental Protection Agency
fps	Feet Per Second
ft/kft	Feet Per 1,000 Feet
GIS	Geographic Information System
gpd	Gallons Per Day

gpd/ac	Gallons Per Day Per Acre
gpcd	Gallons Per Capita Per Day
gpm	Gallons Per Minute
GUI	Graphical User Interface
HGL	Hydraulic Grade Line
HP	Horse Power
ISO	Insurance Service Office
Master Plan	Water Distribution System Master Plan
MDD	Maximum Day Demand
MG	Million Gallons
mgd	Million Gallons Per Day
MMD	Maximum Month Demand
msl	Mean Sea Level
NAVD	North American Vertical Datum
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
ROW	Right-Of-Way
SCWA	Sonoma County Water Agency
UFW	Unaccounted-For-Water
UPC	Uniform Plumbing Code
UWMP	Urban Water Management Plan

1.8 REFERENCE MATERIAL

The following documents were referenced in the preparation of this Master Plan:

- *City of Cotati 2010 Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update*, Final, Maddaus Water Management, November 2010.
- *City of Cotati Standard Details and Specifications*, Final, September 2007.
- *City of Cotati Urban Water Management Plan*, Final, Winzler & Kelly Consulting Engineers, 2006.
- *City of Cotati Water System Master Plan*, Final, Winzler & Kelly Consulting Engineers, May 2002.
- *Restructured Agreement For Water Supply, Sonoma County Water Contractors*, June 2006.

STUDY AREA DESCRIPTION

This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.

2.1 STUDY AREA

According to City staff, growth within the next 25 years is expected to occur within the current City limits. Therefore, the study area boundary for this Water Distribution System Master Plan (Master Plan) and the current City limits are coterminous and will be used interchangeably throughout this report. Figure 2.1 shows the study area boundary, which is roughly bounded by the City of Rohnert Park to the north and east and unincorporated areas of Sonoma County to the south and west.

2.2 PLANNING PERIOD

The Master Plan study area is intended to include the existing City limits and development that could occur through the year 2035. Existing and projected populations and land uses within the study area are discussed in this chapter.

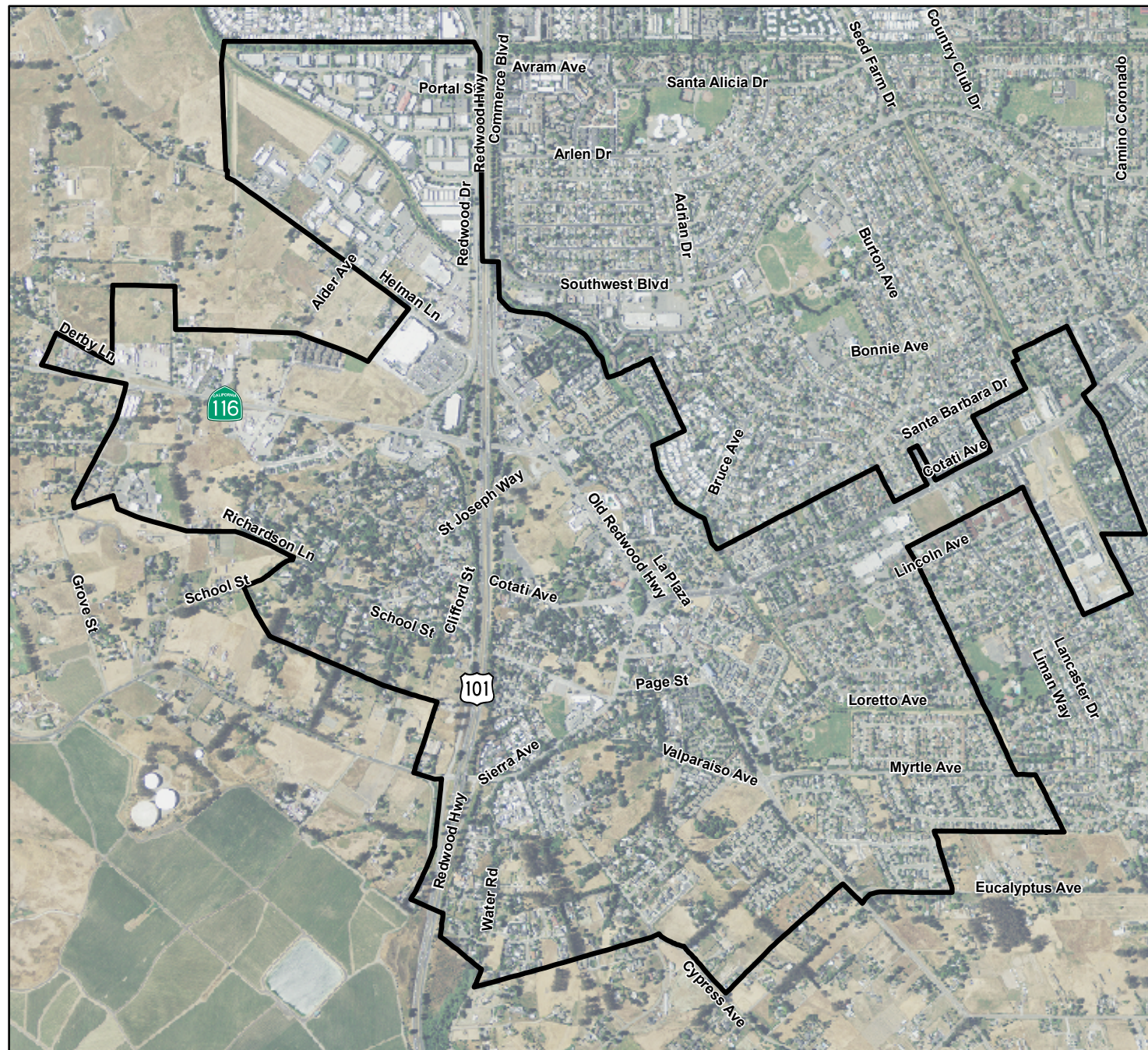
2.3 CLIMATE

The City's study area is characterized by a Mediterranean-type climate with wet, cold winters, and warm, dry summers. Approximately 95 percent of the annual rainfall occurs between November and April, with an average annual rainfall of 24.9 inches¹. The study area elevation ranges from about 93 feet above mean sea level (msl) on the northwest side of the City, to 272 feet msl on the southwest side of the City.

2.4 LAND USE

Land use and population information are integral components in determining the water demand within a City. The type of land use in an area will affect the volume and character of the water demand. Adequately estimating the demand of water from various land use types is important in sizing and maintaining effective water system facilities.

¹ Source: Historical data from Western Regional Climate Center, Petaluma Fire Station 3.



Legend
City Limits



0 1,000 2,000 Feet

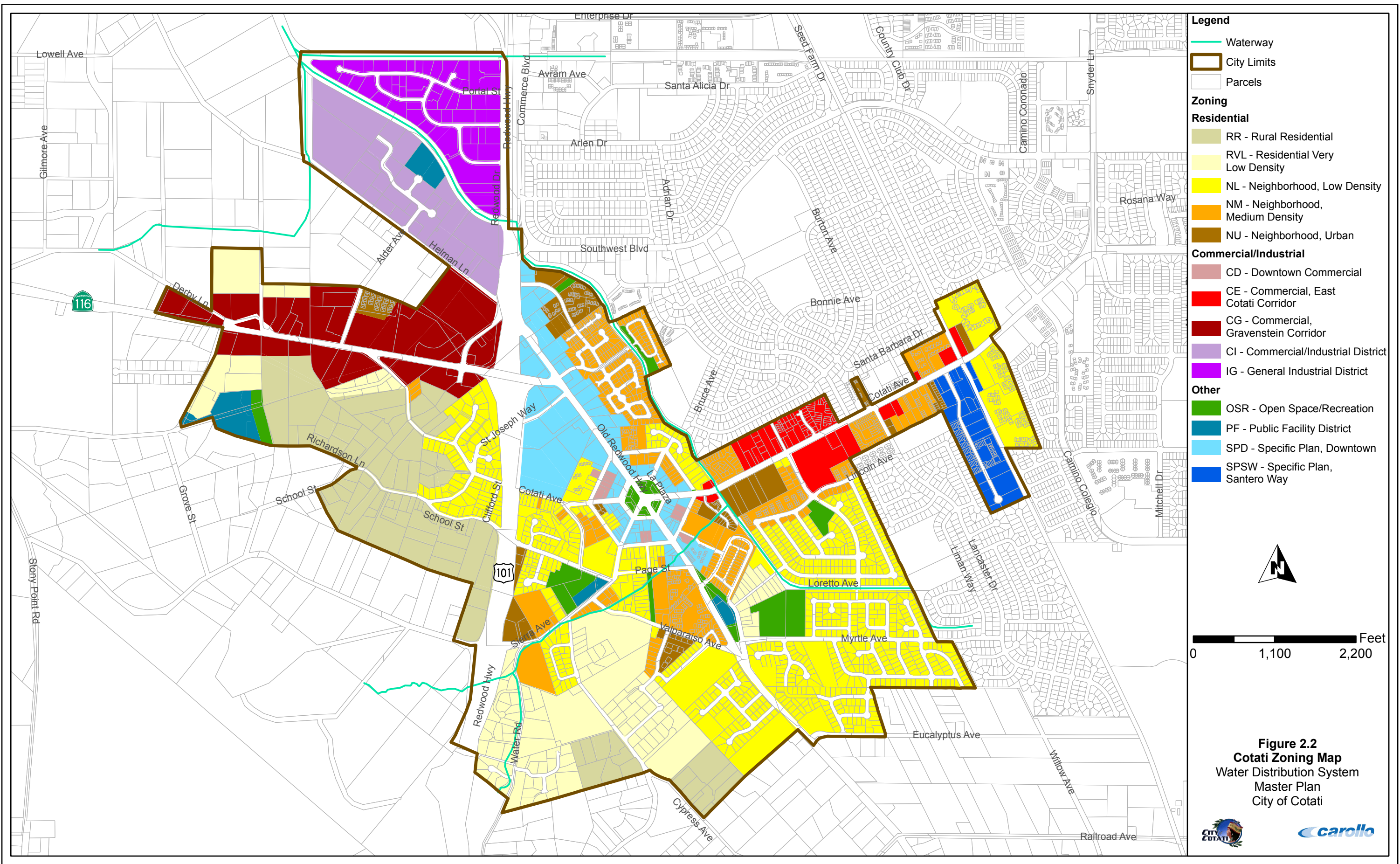
Figure 2.1
Study Area
Water Distribution System
Master Plan
City of Cotati



The City's current General Plan was adopted in 1998. The City is currently planning the process of updating the General Plan. According to City staff, the land use assumptions that will be incorporated into the General Plan Update will be based on the City's current zoning map. For this reason, the land use assumptions used in this Master Plan are consistent with the City's current zoning designations illustrated in Figure 2.2.

The City provides water service to residents, businesses, and other institutions within the study area. Table 2.1 provides the acreage totals by zoning classification within the City limits, and a breakdown between developed land and undeveloped lands.

Table 2.1 Study Area Zoning Designations Water Distribution System Master Plan City of Cotati			
Zoning Designation	Area within the Current City Limits ¹		
	Total (acres)	Developed (acres)	Undeveloped (acres)
CD - Downtown Commercial	3.31	1.23	2.08
CE - Commercial, East Cotati Corridor	27.90	26.14	1.76
CG - Commercial, Gravenstein Corridor	85.17	25.41	59.76
CI - Commercial/Industrial District	64.02	19.06	44.96
IG - General Industrial District	53.56	52.23	1.33
NL - Neighborhood, Low Density	231.41	193.51	37.9
NM - Neighborhood, Medium Density	99.98	89.01	10.97
NU - Neighborhood, Urban	34.79	27.80	6.99
OSR - Open Space - Recreation	26.48	25.16	1.32
PF - Public Facility District	15.45	10.71	4.74
RR - Rural Residential	98.63	78.00	20.63
RVL - Residential Very Low Density	117.38	69.86	47.52
SPD - Specific Plan, Downtown	62.30	28.04	34.26
SPSW - Specific Plan, Santero Way	20.55	6.29	14.26
Total	940.94	652.44	288.5
Notes:			
1. Area totals exclude roads, highways, waterways, etc.			



The largest zoning category is residential (neighborhood, low density; neighborhood, medium density; neighborhood, urban; rural residential; and residential very low density), which accounts for approximately 1,758 acres, or approximately 62 percent of the City limit acreage, excluding streets, highways, waterways, etc. Commercial and industrial zoning (downtown commercial; commercial, east Cotati corridor; commercial Gravenstein corridor; commercial/industrial district; and general industrial district) make up approximately 25 percent of the total. Other land uses such as open space - recreation, public facility district, and specific plans (specific plan, downtown and specific plan, Santero Way) account for the remaining 13 percent of the City limits, excluding streets, highways, and waterways.

As previously noted, the City does not anticipate that it will annex any additional land areas beyond the current City limits within the planning period of this Master Plan. For this reason, land use assumptions in this study do not extend beyond the current City limits. As shown in Table 2.1, there is roughly 290 acres of developable land within the current City limits, and this Master Plan assumes that future water demands will be generated from that available development area.

2.5 HISTORICAL AND FUTURE POPULATION

In order to retain its distinct character, preserve its name, and guide its future growth, Cotati incorporated in 1963². The City's roots are steeped in agriculture and music, and its citizens are proud of the diverse and charming community that has been shaped through its history.

According to California Department of Finance (DOF) population estimates, Between 1970 and 2005, the City's population grew by roughly 5,816 residents, from 1,368 in 1970, to 7,184 residents in 2005. Over these 35 years, that growth equated to an annual rate of about 4.9 percent on average.

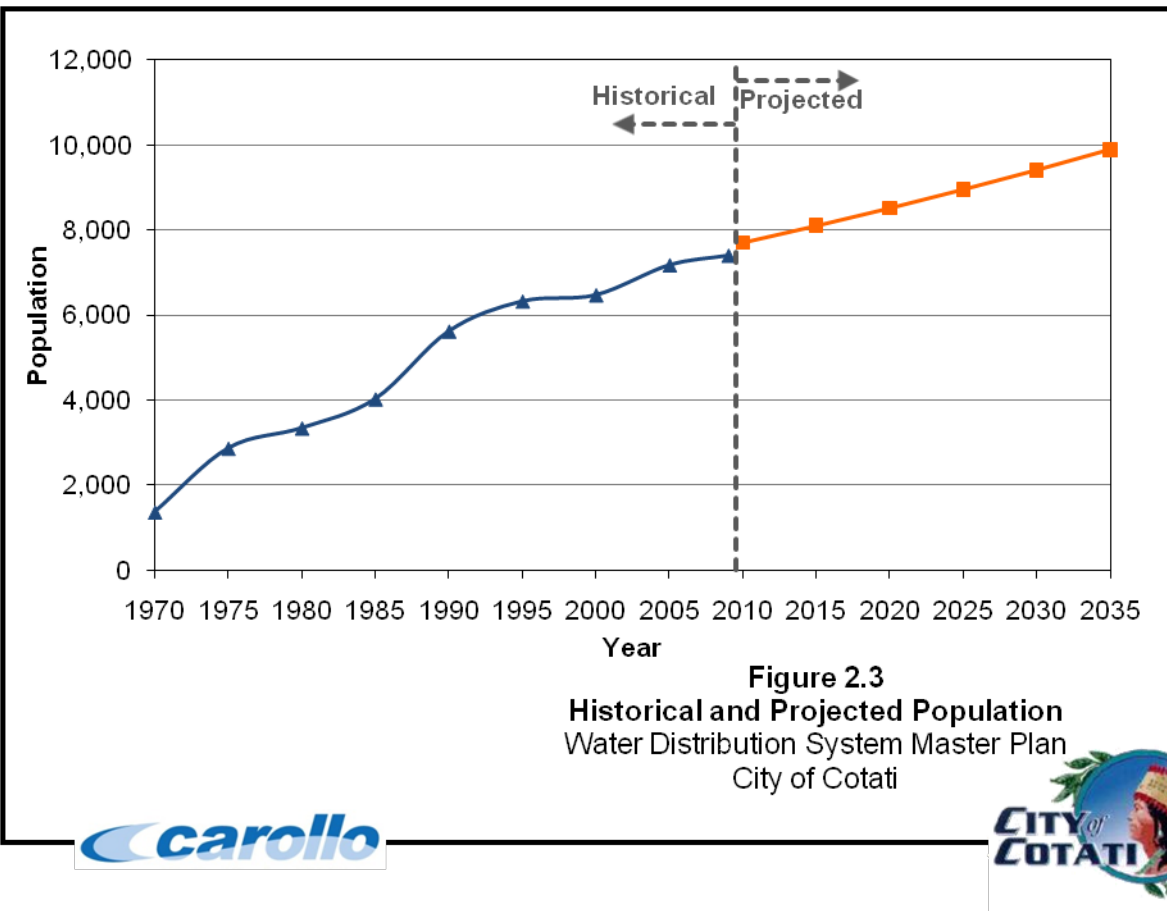
Population projections used in this Master Plan are based on forecasts provided in the City's Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update, dated November 2010 (Maddaus Report). The population forecasts presented in the Maddaus Report project that the City will reach a population of approximately 9,889 people by 2035. Table 2.2 and Figure 2.3 summarize the City's historical and projected population to year 2035.

² <http://www.ci.cotati.ca.us/>

Table 2.2 Historical and Projected Population Water Distribution System Master Plan City of Cotati			
Year	Population ^{(1),(2)}	Year	Population ^{(1),(2)}
1970	1,368	2005	7,184
1975	2,870	2010	7,711
1980	3,346	2015	8,105
1985	4,030	2020	8,518
1990	5,625	2025	8,953
1995	6,332	2030	9,409
2000	6,480	2035	9,889

Note:

1. Historical population based on California Department of Finance estimates for the City of Cotati.
2. Population projections provided in the City of Cotati Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update, November 2010.



PLANNING CRITERIA

The capacity of the City of Cotati's (City) water distribution system was evaluated based on the planning criteria defined in this chapter. The criteria include standards from the City's Standard Details and Specifications and other planning criteria developed by Carollo based on engineering judgment and past experience. The planning criteria address the distribution system water supply capacity, storage requirements, service pressures, distribution mains, fire flows, and peaking factors.

3.1 WATER DISTRIBUTION SYSTEM

Capacity analysis of the water distribution system will be performed in accordance with the criteria established in this chapter. The City's Standard Details and Specifications stipulate general policies of the City and outline water design criteria. Some of these criteria are discussed below. If not discussed in this report, the reader should assume that the evaluation criteria conform to the Standard Details and Specifications.

3.1.1 Water Supply Capacity

In determining the adequacy of the water supply facilities, the source must be large enough to meet the varying water demand conditions, as well as provide sufficient water during potential emergencies such as power outages and natural or created disasters.

This study does not include an analysis of the groundwater aquifer yield.

3.1.1.1 Firm Supply Capacity

In accordance with industry standard practices and the California Department of Public Health (CDPH) criteria for "New and Existing Source Capacity" on water supply, at all times, a public water system's water source shall have the capacity to meet the system's maximum day demand (MDD). For reliability purposes, it is desirable to maintain a firm water supply capacity equal to or greater than the MDD. Firm capacity is equal to the total capacity of the City's groundwater and surface water supplies, minus the capacity of the largest water source. In the City's case, the largest single source of supply is the Sonoma County Water Agency (SCWA) aqueduct. Therefore, this study recommends that the City be capable of supplying the MDD through the use of groundwater wells alone.

3.1.2 Storage Requirements

The principal function of storage is to provide a reserve supply of water for: 1) operational equalization; 2) fire reserve; and 3) emergency needs. Operational equalization storage is directly related to the amount of water necessary to meet peak demands. The intent of operational equalization storage is to provide the difference in quantity between the customer's peak demands and the system's ability to reliably produce water. The volume of

water allocated for emergency uses is decided based on the historical record of emergencies experienced, and on the amount of time which is expected to lapse before a hypothetical emergency can be corrected.

3.1.2.1 Operational Equalization Storage

Operational Equalization Storage is the amount of stored water in a system required to regulate fluctuations in demand so that extreme variations will not be imposed on the source of supply. Operational equalization storage typically serves the peak demands exerted within the MDD. With operational equalization storage, system pressures are improved and stabilized to better serve customers throughout the service area. Operational equalization storage is commonly estimated between 10 percent and 50 percent of the MDD. Operational equalization storage equal to 25 percent of the City's MDD is recommended based on the size and configuration of the City's system, as well as Carollo's experience on similar projects.

American Waterworks Association (AWWA) Manual M32 states that operational storage is typically between 10 to 15 percent of the MDD for large systems, but could exceed 30 percent for small systems or arid climates.

The CDPH's revised Waterworks Standards, which became effective in 2008, stipulate that a water system shall be able to meet four hours of peak hour demand (PHD) with source capacity, storage capacity, and/or emergency source connections. Four hours of PHD is approximately equal to 25 percent of the MDD, which is equal to the recommended operational equalization storage.

3.1.2.2 Fire Storage

Fire storage is the amount required to meet the fire flow demands. The recommended fire storage volume is determined by multiplying the highest required fire flow by its corresponding duration. For municipalities with multiple pressure zones, the recommended fire storage is determined by pressure zone.

The recommended fire flows and durations used in this Master Plan is summarized in Section 3.1.5. The maximum recommended fire flow and duration are 2,500 gallons per minute (gpm) for a duration of two hours. This provision equates to a storage requirement of 0.30 million gallons (MG) and will allow the water system to respond to fires in residential, commercial, or industrial areas.

3.1.2.3 Emergency Storage

This storage is the volume recommended to meet demands during emergency situations such as pipeline failures, major distribution main failures, pump failures, electrical power outages, or natural disasters. The amount of emergency storage included within a particular water distribution system is an owner option, based on an assessment of risk, the desired degree of system reliability, economic considerations, and water quality concerns. In

California, emergency storage is usually estimated at 50 to 100 percent of the MDD. However, consistent with the 2002 Water System Master Plan, this study recommends an emergency storage equal to 100 percent of the average day demand (ADD) (100 percent of the ADD is approximately equal to 50 percent of the MDD).

3.1.2.4 Total Storage

The total storage capacity for the City's system is determined by adding the operational, fire flow, and emergency storage components together as shown in the equation below, where V_s is the total required storage volume, in gallons.

$V_s = \text{Operational Storage} + \text{Fire Storage} + \text{Emergency Storage}$

$V_s = 25 \text{ percent of MDD} + \text{Fire Flow} + 100 \text{ percent of ADD, or}$

$V_s = 0.25 \times \text{MDD} + 1.0 \times \text{ADD} + 0.30 \text{ MG}$

where:

MDD is the maximum day demand, in gallons

Fire Flow is equivalent to 0.30 MG

The City currently operates one active storage tank with a total volume of 1.0 MG.

3.1.3 Service Pressures

Pressures maintained within distribution system vary depending on distribution system operations and pressure zone topography. It is essential that the water pressure in a residence or place of business be neither too high, nor too low. Pressures, below 30 pounds per square inch (psi) cause annoying flow reductions when more than one water-using appliance is used. High pressures may cause faucets to leak and valve seats to wear out quickly. Additionally, high service pressures usually result in wasted water and high water utility bills. The Uniform Plumbing Code (UPC) requires that water pressures not exceed 80 psi at service connections, unless the service is provided with a pressure-reducing device.

The AWWA Manual M32 indicates that pressures between 30 psi and 90 psi are generally expected during the range of system water demands including: ADD, MDD, maximum storage replenishment rate, and PHD. The maximum replenishment rate is the maximum flow rate required during periods where storage tanks are filling. Based on Carollo's experience with water system planning, it is recommended that a minimum pressure of 35 psi be maintained during the PHD, while a pressure of 40 psi is maintained during the MDD.

Consistent with the CDPH revised Waterworks Standards, the fire pressure criterion requires a minimum acceptable residual pressure of 20 psi at the connecting hydrant.

3.1.4 Distribution Mains

Transmission mains are generally sized to carry the greater of: 1) the PHD; or 2) the MDD plus fire flow. Other criteria related to the distribution system include the maximum and minimum velocities and the maximum allowable friction losses.

3.1.4.1 Velocities During Normal Conditions

High velocities may cause damage to pipes and to their appurtenances. Normally, velocities of 10 feet per second (fps) (AWWA M32), or higher, do not cause ill effects if they occur for a limited duration, such as during a fire flow conditions that last two to three hours. It is normally good practice to limit pipe velocities to no more than 8 fps on a continuous basis. For this reason, pipeline velocity for the existing distribution system pipelines should not exceed 10 fps under normal PHD conditions and 8 fps under normal MDD conditions.

New distribution system pipelines 12 inches in diameter or less will be sized with a maximum pipeline velocity of 5 fps for normal PHD conditions, while new distribution system pipelines 16 inches in diameter or more will be sized with a maximum pipeline velocity of 4 fps under normal PHD conditions.

Provided that the maximum velocity criteria and the pressure criteria are not exceeded, high head loss by itself is not a controlling factor. However, it may be an indication that the pipe is nearing the limit of its carrying capacity, and may not have sufficient capacity to perform under stringent conditions. Good practice dictates monitoring pipes that have a head loss in excess of 10 feet per 1,000 feet (ft/kft) (AWWA M32). Therefore, the maximum headloss should not exceed 10 ft/kft in existing pipelines under normal PHD conditions. New pipelines should be sized for a maximum headloss of 5 ft/kft under normal PHD conditions.

The roughness coefficients for calculating head loss in pipes will be based on industry standards for similar pipe materials and service age, as detailed in Table 3.1.

3.1.4.2 Velocity During Fire Flow Conditions

For MDD plus fire flow conditions, the most critical test of a pipeline's adequacy is the delivery pressure at the hydrant location. Excessive pipeline velocities and headlosses are used to identify pipelines with a limited carrying capacity. Replacing these pipelines or constructing parallel pipelines, increases the residual pressure and therefore the available fire flow at the hydrant.

However, due to the relatively short duration in which these conditions occur, if the hydrant delivery pressure is adequate (i.e., greater than 20 psi), high pipeline headloss or velocity is typically not a major concern.

Table 3.1 Pipe Roughness Water Distribution System Master Plan City of Cotati						
Pipe Material	Age (Years)					
	0-10	10-20	20-30	30-40	40-50	50+
Asbestos Cement	125	125	125	125	125	125
Cast Iron	120	110	100	90	80	70
Ductile Iron	130	125	120	115	110	105
Plastic (PVC)	140	140	140	140	140	140
Steel	130	120	110	100	90	80
Note: At age = 0, the roughness coefficients are commonly used values for new pipes. Roughness coefficients decrease with age at a rate that depends on pipe material. For planning purposes, roughness of Asbestos Cement and PVC pipes are assumed constant, while the remaining pipe materials decrease by age.						

3.1.5 Fire Flows

Fire flows stress a water system in the area of the fire and often identify existing deficiencies. The deficiencies are generally associated with pipe sizes (diameter) or age (roughness) that results in high headloss and lower pressures. The fire flow criteria measures a system's ability to deliver a high rate of water while maintaining a minimum pressure.

To evaluate the effect of fire flows throughout the distribution system, large point demands are applied at fire hydrants. The fire flow demands are run concurrent with the maximum day demand. Simulating maximum day demand plus fire flows also demonstrates the performance of supply sources and storage tanks operating under the upper limit high demand conditions.

Below are the recommended fire flow criteria for the different land uses:

- Residential fire flows: 1,500 gpm for a duration of two hours
- Commercial fire flows: 1,500 gpm for a duration of two hours
- Industrial fire flows: 2,500 gpm for a duration of two hours
- Agricultural/Rural Residential/Parks fire flows: 1,500 gpm for a duration of two hours

These fire flow criteria were developed based on a review of the applicable provisions of the City's Standard Details and Specifications, the City's 2002 Water System Master Plan, the California Fire Code, and the Fire Suppression Rating Schedule, published by the Insurance Service Office (ISO). Certain facilities, such as large manufacturing facilities, may require fire flows in excess of those listed, as stipulated by the California Fire Code. This master plan assumes that all required fire flows in excess of those summarized above

would be met through private on-site water supplies or supplemental storage. This approach is consistent with industry standard practice.

WATER DEMAND

This chapter summarizes the City of Cotati's (City) historical water consumption and production records used to determine the daily, monthly, and seasonal fluctuations experienced by the water system. Also summarized are the average day water demand coefficients, daily and hourly peaking factors, and the projected demands through year 2035.

4.1 HISTORICAL WATER USE

The City relies on groundwater water purchased from the Sonoma County Water Agency (SCWA) and local groundwater to meet its customer demands. This section summarizes the City's historical water use, including consumption and production per capita water use, seasonal water use and peaking factors.

4.1.1 Historical Production and Consumption

Table 4.1 lists the City's historical water consumption and production from 1995 through 2009. During this time period, the City's annual average consumption ranged from 0.77 million gallons per day (mgd) in 2009 to 0.96 mgd in 2001, while the City's annual average production ranged from 0.84 mgd in 1995 to 1.10 mgd in 2000.

The average production percentage by source for 1995 through 2009 is illustrated in Figure 4.1. The majority of the City's water demands were met through the SCWA wholesale supply source, accounting for roughly 72 percent of City's supply. The remaining 28 percent of supply from 1995 through 2009 was supplied through the City's three groundwater wells.

Table 4.1 also summarizes the City's unaccounted-for-water (UFW) from 1995 through 2009, which was computed by subtracting the total annual consumption by the total annual production. As a percentage of total production, the City's UFW ranged from a low of roughly three percent in 1995 to a high of 16 percent in 2000. UFW accounts for roughly 10 percent or less of the total demand in a typical water system in California. UFW can be caused by a number of factors, such as leakage, meter inaccuracies, authorized unmetered use (e.g., hydrant flushing, tank cleaning, other maintenance activities, fire fighting exercises, etc.), unauthorized or illegal water use, and/or other factors.

The City's UFW accounted for ten percent or more of the City's total production in ten of the 15 years of historical data shown on Table 4.1. The City has not identified the cause of the high rate of UFW in the water distribution system. There is a potential for the City to reduce its overall water demand through the identification of UFW sources in the distribution system.

Table 4.1 Historical Water Production and Consumption Water Distribution System Master Plan City of Cotati										
		Consumption ⁽²⁾		Production (SCWA + Groundwater) ⁽²⁾					Unaccounted-for-Water ⁽³⁾	
		Annual Total (MG)	Daily Average (mgd)	Annual Total (MG)	Average Day Demand (mgd)	Per Capita Demand (gpcd)	Maximum Month Demand (mgd)	Maximum Month: Average Day Ratio	Annual Total (MG)	Percentage of Production ⁽³⁾ (%)
Year	Population ⁽¹⁾									
1995	6,332	297.5	0.81	305.8	0.84	132	1.44	1.72	8.3	3%
1996	6,327	323.5	0.88	357.4	0.98	154	1.56	1.60	33.9	9%
1997	6,345	338.2	0.93	386.9	1.06	167	1.69	1.60	48.7	13%
1998	6,417	315.4	0.86	351.2	0.96	150	1.63	1.70	35.8	10%
1999	6,487	337.4	0.92	359.5	0.98	152	1.62	1.64	22.1	6%
2000	6,480	339.6	0.93	403.7	1.10	170	1.56	1.42	64.1	16%
2001	6,496	352.2	0.96	402.0	1.10	170	1.67	1.51	49.8	12%
2002	6,700	341.8	0.94	402.0	1.10	164	1.87	1.69	60.3	15%
2003	6,735	327.8	0.90	387.6	1.06	158	1.64	1.54	59.8	15%
2004	6,925	342.3	0.94	392.0	1.07	155	1.73	1.61	49.7	13%
2005	7,184	313.8	0.86	363.7	1.00	139	1.73	1.74	50.0	14%
2006	7,227	338.5	0.93	364.2	1.00	138	1.63	1.63	25.7	7%
2007	7,371	328.5	0.90	372.9	1.02	139	1.56	1.53	44.4	12%
2008	7,382	335.9	0.92	342.3	0.94	127	1.36	1.46	6.4	2%
2009	7,409	280.8	0.77	329.8	0.90	122	1.37	1.51	48.9	15%
Average						149		1.59		11%
Notes: 1. Source: California Department of Finance Estimates for the City of Cotati. 2. Source: City Production and Consumption Data. 3. Unaccounted-for-Water = Production - Consumption. Percentage is presented relative to production.										

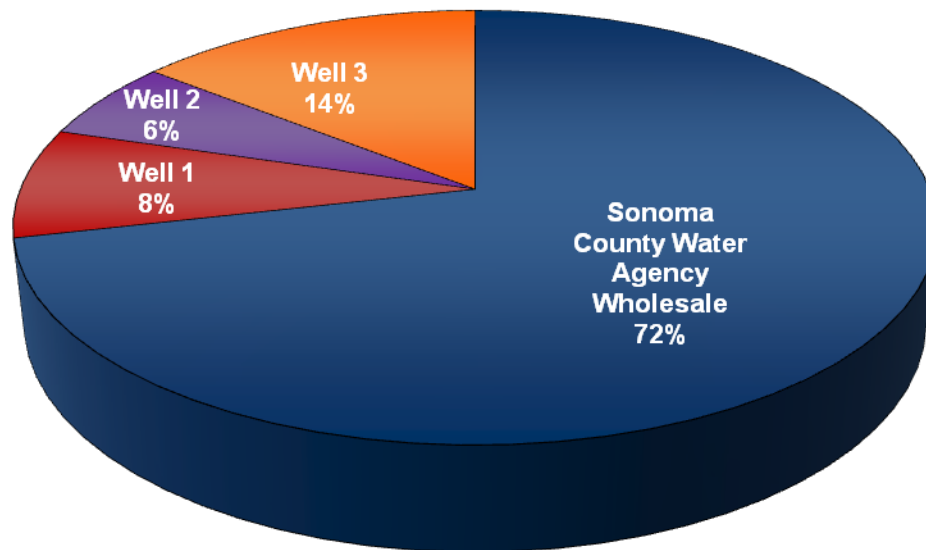


Figure 4.1
Historical Production
by Source (1995 - 2009)
 Water Distribution System Master Plan
 City of Cotati



4.1.2 Per Capita Water Use

The per capita consumption rate is commonly used for estimating future water requirements, evaluating the adequacy of the supply source, and determining storage needs. The consumption rate, expressed in gallons per capita per day (gpcd), can also be used as a benchmark for comparison of water usage rates to other municipalities.

Historical City per capita water use is calculated by dividing the City's total production by the total population. Table 4.1 shows the historical water per capita consumption from 1995 to 2009. The average per capita demand ranged between 122 gpcd (2009) and 170 gpcd (2000). Between 1995 and 2009, the average per capita demand was approximately 149 gpcd.

4.1.3 Seasonal Demands and Peaking Factors

Peaking factors represent the seasonal and daily variations in water use, above or below the average day water demand. The various peaking conditions are either statistical concepts or numerical values established through a review of historical data and are, at times, adjusted to reflect a level of conservatism.

Peaking conditions that are of particular significance to hydraulic analysis of the water system include the average day demand (ADD), maximum month demand (MMD), maximum day demand (MDD), and the peak hour demand (PHD). Peaking factors for

expressing these demands as a function of the ADD were developed based on the City's production records when available and industry standards when historical data was not available. Table 4.1 summarizes the ADD and the MMD from 1995 through 2009.

4.1.3.1 Average Day Demand (ADD)

The ADD is the total annual production divided by number of days in the year. For example, in 2000, the ADD was approximately 1.10 mgd, and in 2009, the ADD was 0.90 mgd.

4.1.3.2 Maximum Month Demand (MMD)

The MMD is the average daily demand for the month with the highest production during the year, usually occurring in the summer. The MMD peaking factor is expressed as a multiplier applied to the ADD, and is used primarily in the evaluation of supply capabilities. As shown in Table 4.1, the average ratio of MMD to ADD from 1995 to 2009 was 1.6, which based on our experience on previous projects, is in the range of typical values.

$$\text{Maximum Month Demand} = 1.6 \times \text{Average Day Demand}$$

4.1.3.3 Maximum Day Demand (MDD)

The MDD is the greatest water demand during a 24-hour period of the year. The MDD peaking factor is expressed as a multiplier applied to the ADD. Water system supply sources are typically sized to meet the anticipated MDD of a water system. In general, the MDD is 2.0 to 2.5 times greater than the ADD.

Daily production data was not available from the SCWA turnouts to determine the MDD, so a MDD peaking factor was calculated based on guidelines from the California Department of Public Health's (CDPH's) revised Waterworks Standards. The CDPH recommends a MDD to MMD peaking factor of at least 1.5, which equates to 2.4 times the ADD in the case of the City.

$$\begin{aligned}\text{Maximum Day Demand} &= 1.5 \times \text{Maximum Month Demand} \\ &= 1.5 \times 1.6 \times \text{Average Day Demand} \\ &= 2.4 \times \text{Average Day Demand}\end{aligned}$$

4.1.3.4 Peak Hour Demand (PHD)

The PHD is the highest water demand during any one-hour period of the year. A normal day typically experiences two peak demands, in the morning and then evening. The PHD is expressed as a multiplier applied to the ADD. PHD hydraulic simulations model high water use throughout the system and assist in identifying areas of the distribution system that experience low pressures.

In general, the PHD ranges between 2.5 and 3.5 times greater than the ADD. Hourly demands were not available for this project, so a PHD peaking factor was calculated based

on guidelines from the CDPH Waterworks Standards. The CDPH recommends a PHD to MDD peaking factor of at least 1.5, which equates to 3.6 times the ADD.

$$\text{Peak Hour Demand} = 1.5 \times \text{Maximum Day Demand}$$

$$= 1.5 \times 2.4 \times \text{Average Day Demand}$$

$$= 3.6 \times \text{Average Day Demand}$$

4.2 EXISTING AND PROJECTED WATER DEMAND

For water distribution system master plans, developing relationships between land use and demand is a method typically employed to develop average day demands. These relationships, called water demand coefficients are established based on the average water demand for each existing land use type. The land use demand coefficients are established based on per capita demand values, the documented number of dwelling units per acre for each land use type and the City's number of people per dwelling unit, and are then refined based on actual water meter billing data. The land use demand coefficients were established to estimate ADD within the study area.

4.2.1 Existing and Future Water Demand Coefficients

The average day water demand coefficients are factors that provide a means to transform a land use or zoning category from acreage into a water demand. The demand coefficient is expressed in units of gallons per day per acre (gpd/ac), and when multiplied by the land use or zoning acreage, the product is equal to the average water demand for that land use or zoning designation. The resulting demand is then allocated into the water distribution system model for each land use or zoning type.

The water demand coefficients developed for this Master Plan are summarized in Table 4.2. To verify the validity of the demand coefficients, the existing developed lands within the City limits were multiplied by the appropriate demand coefficients. The resulting ADD was approximately 0.98 mgd, which matches the 2010 water demand provided in the City's Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update, dated November 2010 (Maddaus Report). A copy of the Maddaus Report is included in Appendix A for reference.

4.2.2 Future Water Demands

Developing an accurate estimate of the water demand is an important step in determining the size of water distribution system facilities, for both existing conditions and future developments.

Table 4.2 Water Demand Coefficients and Projected ADD Water Distribution System Master Plan City of Cotati						
Zoning Designation	Land Use Totals		Water Demand Flow Estimates			
	Developed (acres)	Total (acres)	ADD Coefficient		Existing (2010) ADD (gpd)	Future (2035) ADD (gpd)
			Existing ⁽¹⁾ (gpd/ac)	Future ⁽²⁾ (gpd/ac)		
CD - Downtown Commercial	1.23	3.31	2,900	2,300	3,580	8,350
CE - Commercial, East Cotati Corridor	26.14	27.90	2,000	1,600	52,274	55,102
CG - Commercial, Gravenstein Corridor	25.41	85.17	1,400	1,100	35,569	101,314
CI - Commercial/Industrial District	19.06	64.02	1,000	800	19,065	55,028
IG - General Industrial District	52.23	53.56	900	700	47,011	47,940
NL - Neighborhood, Low Density	193.51	231.41	1,600	1,300	309,614	358,884
NM - Neighborhood, Medium Density	89.01	99.98	2,300	1,800	204,717	224,471
NU - Neighborhood, Urban	27.80	34.79	3,300	2,600	91,725	109,919
OSR - Open Space - Recreation	25.16	26.48	1,300	1,000	32,704	34,028
PF - Public Facility District	10.71	15.45	1,100	850	11,779	15,809
RR - Rural Residential	78.00	98.63	400	300	31,200	37,389
RVL - Residential Very Low Density	69.86	117.38	900	700	62,870	96,140
SPD - Specific Plan, Downtown	28.04	62.30	2,300	1,800	64,489	126,157
SPSW - Specific Plan, Santero Way	6.29	20.55	4,200	3,300	26,437	73,465
Total	652.44	940.94	--	--	993,034	1,343,996
Notes: 1. Existing coefficients were adjusted to match the 2010 annual water demand provided by Maddaus Water Management. 2. The future coefficients were adjusted to account for conservation savings associated with the implementation of both the Federal and State Plumbing Code requirements.						

The Maddaus Report provides water demand projections for the City for its use in the 2010 Urban Water Management Plan (UWMP). The developed projections account for future water conservation that is associated with the implementation of both the Federal and State Plumbing Code requirements. For this reason, Table 4.2 includes reduced future water demand coefficients that account for the future water conservation associated with the plumbing codes. Following this methodology, the resulting future year 2035 ADD is approximately 1.34 mgd, which matches the projections provided in the Maddaus Report.

A summary of the existing and future ADD is presented in Table 4.3. In addition to the projected average demands, Table 4.3 includes estimates for the MDD and PHD through year 2035. Based on these projections, it is anticipated that the City's year 2035 ADD, MDD, and PHD will approach 1.34 mgd, 3.22 mgd, and 4.83 mgd, respectively.

Table 4.3 Water Use Demand Summary Water Distribution System Master Plan City of Cotati			
Year	Average Day Demand (mgd)	Maximum Day Demand (mgd)	Peak Hour Demand (mgd)
Existing (2010)	0.98	2.36	3.54
Build-Out (2035)	1.34	3.22	4.83

4.3 PLANNING CRITERIA SUMMARY

The planning criteria for this Master Plan are summarized in Table 4.4.

Table 4.4 Planning Criteria Summary Water Distribution System Master Plan City of Cotati						
Source of Supply						
The adequate source of supply is required to meet:		Near Term and Build-out	Maximum Day Demand with the firm supply capacity (total capacity less largest supply source)			
Storage						
The adequate Pressure Zone storage shall meet:		Operational Storage	= 25 percent of Maximum Day Demand			
		Fire Storage	= 0.30 MG (2,500 gpm for 2 hours)			
		Emergency Storage	= 100 percent Average Day Demand			
Distribution Mains						
The distribution system should be sized to meet the:		Peak Hour Demand				
Criteria for judging the adequacy of existing pipelines:		Maximum desirable pipeline velocity: 8 feet per second (MDD) 10 feet per second (PHD)				
		Maximum desirable headloss: 10 feet/1,000 feet (PHD)				
Criteria for sizing new pipelines:		Maximum pipeline velocity, pipes 12-inches and smaller: 5 feet per second (PHD)				
		Maximum pipeline velocity, pipes 16-inches and larger: 4 feet per second (PHD)				
		Maximum headloss (all pipe sizes): 5 feet/1,000 feet (PHD)				
Headloss in Pipes (Roughness Coefficients)						
Headloss in pipes was calculated based on the following roughness coefficient table:						
		Age (Years)				
Pipe Material	0	10	20	30	40	50
Asbestos Cement	125	125	125	125	125	125
Cast Iron	120	110	100	90	80	70
Ductile Iron	130	125	120	115	110	105
Plastic (PVC)	140	140	140	140	140	140
Steel	130	120	110	100	90	90
Service Pressures						
The recommended low pressures are as follows:		Maximum Pressure (during ADD)		= 90 psi		
		Minimum Pressure (during MDD)		= 40 psi		
		Minimum Pressure (PHD)		= 35 psi		
		Minimum Residual Pressure (MDD + Fire)		= 20 psi		
Water Use Peaking Factors						
Fluctuations in water demands were based on:		Maximum Month Demand		= 1.6 x Average Day Demand		
		Maximum Day Demand		= 2.4 x Average Day Demand		
		Peak Hour Demand		= 3.6 x Average Day Demand		
Average Day Demand Coefficients						
These demand coefficients are applied to the land use acreages to yield average day water demands:						
		Coefficients				
Land Use Category	Existing (gpd/ac)	Future (gpd/ac)				
CD - Downtown Commercial	2,900	2,300				
CE - Commercial, East Cotati Corridor	2,000	1,600				
CG - Commercial, Gravenstein Corridor	1,400	1,100				
CI - Commercial/Industrial District	1,000	800				
IG - General Industrial District	900	700				
NL - Neighborhood, Low Density	1,600	1,300				
NM - Neighborhood, Medium Density	2,300	1,800				
NU - Neighborhood, Urban	3,300	2,600				
OSR - Open Space - Recreation	1,300	1,000				
PF - Public Facility District	1,100	850				
RR - Rural Residential	400	300				
RVL - Residential Very Low Density	900	700				
SPD - Specific Plan, Downtown	2,300	1,800				
SPSW - Specific Plan, Santero Way	4,200	3,300				
Fire Flows						
In the study, water system response is adequate when it provides the following flows:		Residential fire flow		= 1,500 gpm for a duration of 2 hours		
		Commercial fire flow		= 1,500 gpm for a duration of 2 hours		
		Industrial fire flow		= 2,500 gpm for a duration of 2 hours		
		Ag/Rur Res/Parks fire flow		= 1,500 gpm for a duration of 2 hours		

DISTRIBUTION SYSTEM FACILITIES AND HYDRAULIC MODEL

This chapter describes the development and calibration of the City of Cotati (City) water supply, water distribution system, and storage facilities. This section outlines the hydraulic model creation process. The City's hydraulic model will be used to identify the water distribution system's capacity deficiencies and to develop improvements to correct those deficiencies.

5.1 WATER DISTRIBUTION SYSTEM OVERVIEW

The City's water supply system consists of two turnouts from the Sonoma County Water Agency (SCWA), as well as three groundwater wells. Water is transmitted from the City's supply sources to the consumers via a distribution system with pipe sizes ranging from 4 to 16-inches in diameter. The City's distribution system also includes two storage tanks, one of which is currently out of service. Figure 5.1 shows the City's current water distribution system, including pipe diameters, as well as groundwater wells, SCWA turnouts, and storage tank locations.

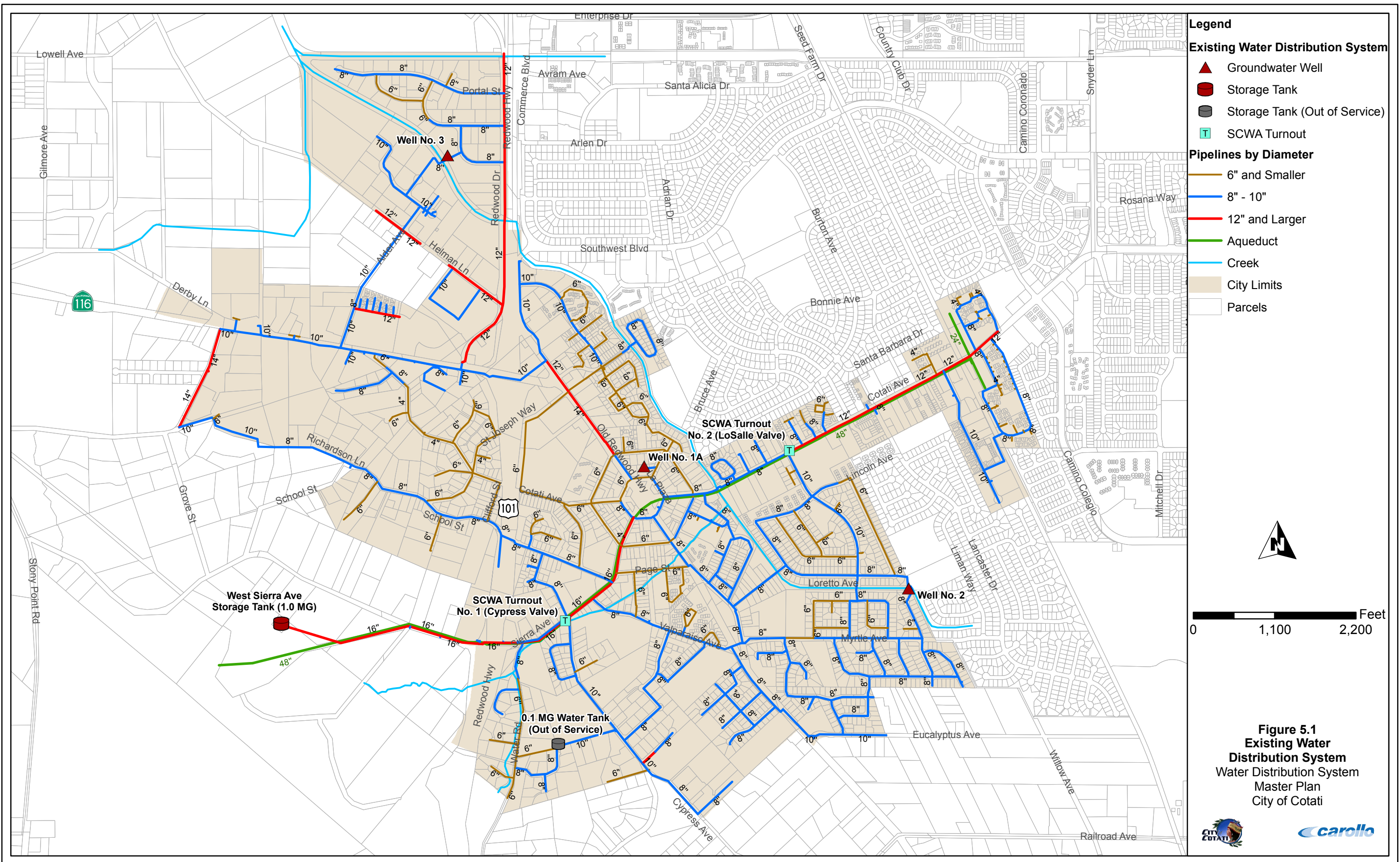
5.1.1 Distribution System

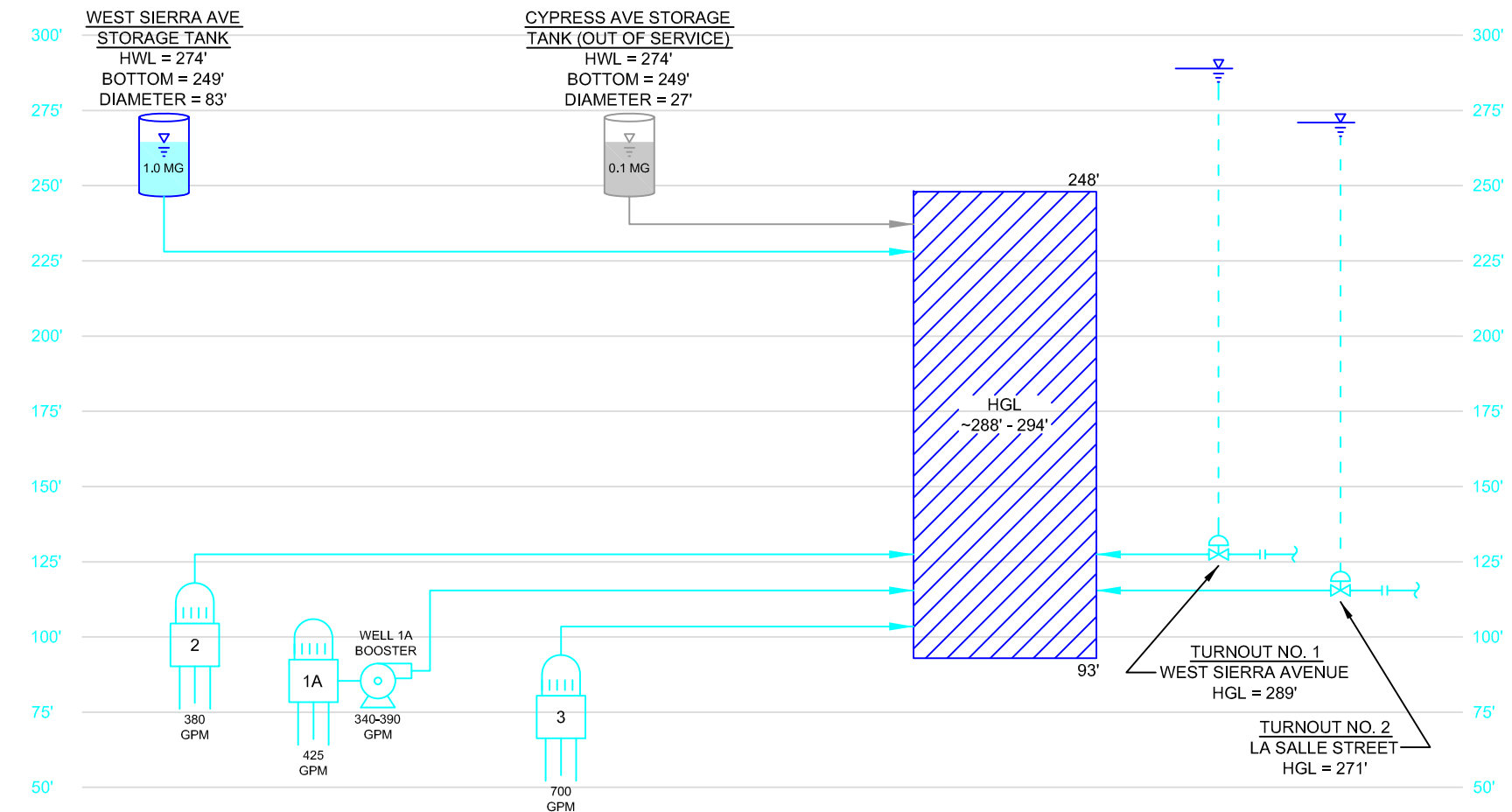
The City's water distribution system consists of approximately 30 miles of active distribution system pipelines ranging in size from 4 to 16-inches in diameter. Table 5.1 presents a summary by diameter of the distribution system pipelines in the City.

Table 5.1 Water Distribution System Pipeline Summary Water Distribution System Master Plan City of Cotati			
Diameter (inch)	Length (feet)	Diameter (inch)	Length (feet)
4	5,056	12	10,535
6	40,467	14	2,747
8	70,269	16	5,836
10	24,897	Total	159,808

5.1.2 Pressure Zones

A hydraulic profile of the water distribution system is shown in Figure 5.2. Service elevations within the City range from approximately 93 feet to 255 feet above mean sea level (msl). The City's water distribution system currently consists of a single pressure zone.





LEGEND

FACILITIES

EXISTING

INACTIVE / OFFLINE

DISTRIBUTION SYSTEM
 HIGH: HIGHEST ELEVATION SERVED IN SYSTEM
 LOW: LOWEST ELEVATION SERVED IN SYSTEM
 HGL: HYDRAULIC GRADE LINE FOR SYSTEM



RESERVOIR
 VOLUME INSIDE TANK



GROUNDWATER WELL
 WELL NO. INSIDE BLOCK



PRESSURE REDUCING
 VALVE



BOOSTER PUMP

Figure 5.2
Hydraulic Profile of the
Water Distribution System
 Water Distribution System Master Plan
 City of Cotati

5.1.3 Groundwater Wells

There are currently three groundwater wells located within the City's water distribution system. The following provides a general summary of the wells, based on information provided by City staff (Appendix B).

- **Well No. 1A:** Well 1, which was constructed in 1975 and subsequently renovated and changed to well 1A in the early 1990s, is equipped with a 25 horse power (HP) vertical turbine pump. The 25 HP pump is rated for a capacity of roughly 425 gallons per minute (gpm) at approximately 125 feet of head.

Based on information from City staff, the 25 HP pump fills a storage tank that supplies a 40 HP booster pump station. The 40 HP booster station has a capacity ranging from 340 gpm to 390 gpm, with an estimated design head of 430 ft. The booster delivers supply to the distribution system by pumping through a pressure filter.

- **Well No. 2:** Well 2, which was constructed in 1976, and renovated in 2009 is equipped with a 50 HP vertical turbine pump. The 50 HP pump is rated for a capacity of roughly 380 gpm at approximately 382 feet of head.
- **Well No. 3:** Well 3, which was constructed in 1979 and subsequently renovated in 2010, is equipped with a 100 HP vertical turbine pump. The 100 HP pump is rated for a capacity of roughly 700 gpm at approximately 380 feet of head.

Table 5.2 summarizes the available data for the groundwater wells.

Table 5.2 Groundwater Well Summary Water Distribution System Master Plan City of Cotati				
Facility Name	Location	Pump⁽²⁾ Station Elevation (feet)	Design Capacity (gpm)	Design Head (ft)
Well 1A	90 East Sierra Avenue in the Hub	106	425	125
Well 1A Booster ⁽³⁾	90 East Sierra Avenue in the Hub	106	340 – 390	430
Well 2	8562 Lakewood Avenue	111.8	380	380
Well 3	Northwest corner of Cotati, along the Laguna near Houser St	94.5	700	380
Notes: 1. Source: Data provided by City staff (Appendix B) 2. Source: City of Cotati 2002 Water System Master Plan (Winzler & Kelly Consulting Engineers) 3. Source: Data provided by City staff				

5.1.4 SCWA Turnouts

The City has two connection points to the SCWA's 48-inch aqueduct that runs through the City along West Sierra Avenue and East Cotati Avenue. The turnouts are both equipped with an isolation valve, flow meter, and a pressure reducing valve (PRV). The PRVs are set to regulate downstream pressures to roughly 70 pounds per square inch (psi). Table 5.3 summarizes the available data for the turnouts.

Table 5.3 Summary of Turnouts from SCWA Water Distribution System Master Plan City of Cotati				
Facility Name	Location	PRV Pressure Setting⁽¹⁾ (psi)	Turnout Elevation⁽¹⁾ (ft)	Turnout HGL⁽¹⁾ (ft)
Turnout No. 1	Intersection of West Sierra Avenue and Cypress Avenue	70	128.1	289.6
Turnout No. 2	East Cotati Avenue, east of LeSalle Avenue	70	109.7	271.2
Notes: 1. Source: City of Cotati 2002 Water System Master Plan (Winzler & Kelly Consulting Engineers)				

5.1.5 Storage Tanks

There are currently two storage tanks located within the City's water distribution system:

- **West Sierra Avenue Storage Tank:** 1.0 million gallons (MG), located west of Highway 101, just south of West Sierra Avenue, outside of the City limits.
- **Cypress Avenue Storage Tank:** 100,000 gallons, located at the end of Loma Linda Avenue. This storage tank is out of service.

Table 5.4 summarizes the available data for the storage tanks.

Table 5.4 Storage Tank Summary Water Distribution System Master Plan City of Cotati						
Facility Name	Location	Status	Volume (MG)	Dimensions⁽¹⁾	Base Elevation⁽¹⁾ (ft)	Overflow Elevation⁽¹⁾ (ft)
West Sierra Avenue Storage Tank	West of Highway 101, south of West Sierra Avenue	In Service	1.0	83' Diameter 27' Height	249	274
Cypress Avenue Storage Tank	End of Loma Linda Avenue	Out of Service	0.1	27' Diameter 25' Height	249	274
Notes: 1. Source: City of Cotati 2002 Water System Master Plan (Winzler & Kelly Consulting Engineers)						

5.2 WATER SYSTEM HYDRAULIC MODEL

This section summarizes the process used to develop the City's hydraulic computer model of the water distribution system, including a summary of the previous model, modeling software selection, the hydraulic model elements, and the model creation process.

5.2.1 Previous Hydraulic Computer Model

The City's previous water distribution system hydraulic model was developed using the WaterCAD® software package, developed by Haestad Methods, which was acquired by Bentley Systems, Incorporated. The hydraulic model contained the physical attributes of the water distribution system facilities (e.g., pipe size, length, tank properties, etc.), water demands, and fire demands.

5.2.2 Selected Hydraulic Model

There is an abundance of water distribution system analysis software in the marketplace today, with a variety of features and capabilities. The selection of a particular model generally depends on user preferences, software costs, and the complexity of the water distribution system.

It was agreed that H₂OMAP Water®, by MWH Soft®, would be used to assemble the City's hydraulic model. H₂OMAP Water® is a comprehensive hydraulic and dynamic water quality modeling software application. The hydraulic modeling engine for the H₂OMAP Water® software package uses the Environmental Protection Agency's (EPA) EPANET model simulation engine, which is widely used throughout the world for planning, analysis, and design related to water distribution systems. The advantage of the H₂OMAP Water®

package over the EPANET software is that it offers an enhanced graphical user interface (GUI) and a variety of additional features and functionality.

Version 9.5 of H₂OMAP Water® was used to initially assemble the hydraulic model, and is currently the most recent version of the software package.

5.2.3 Elements of the Hydraulic Model

The following provides a brief overview of the various elements of the hydraulic model and the required input parameters associated with each:

- **Junctions.** Locations where pipe sizes change, where pipelines intersect, or where water demands are applied are represented by junctions in the hydraulic model. Required inputs for junctions include service elevation and water demands.

Pipes. Water mains are represented as pipes in the hydraulic model. Input parameters for pipes include length, roughness (Hazen Williams C), diameter, and whether or not the pipe is a check valve (i.e., does not allow reverse flow).
- **Tanks.**
 - Cylindrical and Variable Area Tanks: Water tanks are included in the hydraulic model as either cylindrical tanks or variable area tanks, depending on the complexity of the tank geometry. Required input parameters for cylindrical tanks include bottom elevation, maximum level, initial level, and diameter. Required input parameters for variable area tanks include bottom elevation, maximum level, initial level, and a curve that varies the cross sectional area of the tank depending on the tank level.
 - Fixed Head Reservoirs: For water distribution system modeling, fixed head reservoirs are used to represent a water source with a constant hydraulic grade line (HGL). Typically, fixed head reservoirs are used to represent water sources, such as groundwater or water supply turnouts such as SCWA. In the case of the SCWA turnouts, they were modeled as fixed head reservoirs with PRVs with the appropriate setting. The required input parameter for a fixed head reservoir is the elevation.
- **Pumps.** Pumps are included in the hydraulic model as links. Input parameters for pumps include pump curves and operational controls.
- **Valves.** A number of different valves, such as PRVs and float valves, are represented as links in the hydraulic model. Required input parameters for valves include diameter, operational controls, and other settings or headloss curves depending on the type of valve.
- **Demands.** Water demands are applied at specific junctions in the hydraulic model. Up to ten different demands can be assigned at a particular junction.

- **Fire Flows.** Fire flows are simulated in the hydraulic model in two ways. The first is by applying a fire demand at a particular junction with a diurnal pattern that applies the fire during a specific time frame (e.g., two hours). However, this method can be very time consuming for City-wide models. The second method is far less time consuming, and involves assigning a fire demand to certain nodes in the model based on land use. The modeling software will then run a system-wide fire flow analysis, in which each junction with an assigned fire flow will be analyzed and a residual pressure will be computed. This eliminates the need to manually run fire flows throughout the system and increases the number of model junctions that can be analyzed. Method two was used in development of this model.

5.2.4 Hydraulic Model Construction

The City's hydraulic model combines information on the physical and operational characteristics of the water distribution system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes and pressures at nodes.

The model creation process consisted of five steps, as described below:

- Step 1 - The hydraulic model elements (pipes, junctions, etc.) from the City's AutoCAD water system plat maps were exported into geographic information system (GIS) format;
- Step 2 - The GIS data was reviewed and formatted to allow easy import into the H₂OMAP Water modeling platform;
- Step 3 - The water distribution system pipeline and facility data were imported into the modeling software and verified. Certain physical and operational data for the City's water distribution system facilities was not available from the GIS data. This type of data, such as pump controls curves, were input manually into the model based on information provided in the City's 2002 Water System Master Plan and City staff.

Once all the relevant data was input into the hydraulic model, the model was reviewed to verify that the model data was input correctly. Additionally, the modeled groundwater wells and turnouts were also checked to verify that they operated correctly.

- Step 4 - The existing water demands were allocated to the model junctions using the City's water billing records. The number of accounts per junction ranged from a single account to close to 60. The average number of accounts per junction was approximately 6.5.
- Step 5 - The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include reporting parameters and output units. Once the run parameters were established, the model was debugged to

ensure that it ran without errors or warnings. For this Master Plan the model was run steady state and not an extended period simulation.

5.3 HYDRAULIC MODEL CALIBRATION

The model calibration consisted of two parts, a macro calibration and a fire flow (hydrant) test calibration. This section describes both of the calibration steps.

5.3.1 Macro Calibration

The initial calibration process consisted of a macro calibration. Initially, Carollo ran the model under existing demand conditions and necessary adjustments were made to produce reasonable system pressures. Such adjustments include modifications of pipeline connectivity, ground elevations, facility characteristics, and pump curves.

The macro calibration process involved several steps to ensure that the model produces reasonable results:

- **Transmission Main Connectivity.** Using the connectivity features of the modeling software, the connectivity of the transmission mains within the distribution system was verified. Problems found using the connectivity locators were reviewed to determine whether adjustments were needed to connectivity within the model. Output reports of pipe flow characteristics, such as headloss (ft/kft) and velocity (fps) were also used to locate problem areas where additional adjustments may be necessary.
- **System Pressures.** The macro calibration compared the model output to typical pressures observed within the distribution system. This process was used to locate major errors in model creation, elevations, or GIS connectivity, as well errors in pump.
- **Facility Characteristics.** Hydraulic model results were compared to data provided by the City to verify that facility attributes entered into the model, such as characteristics of the SCWA turnouts, groundwater depth, and pump curves, produced results comparable to what the City experiences.

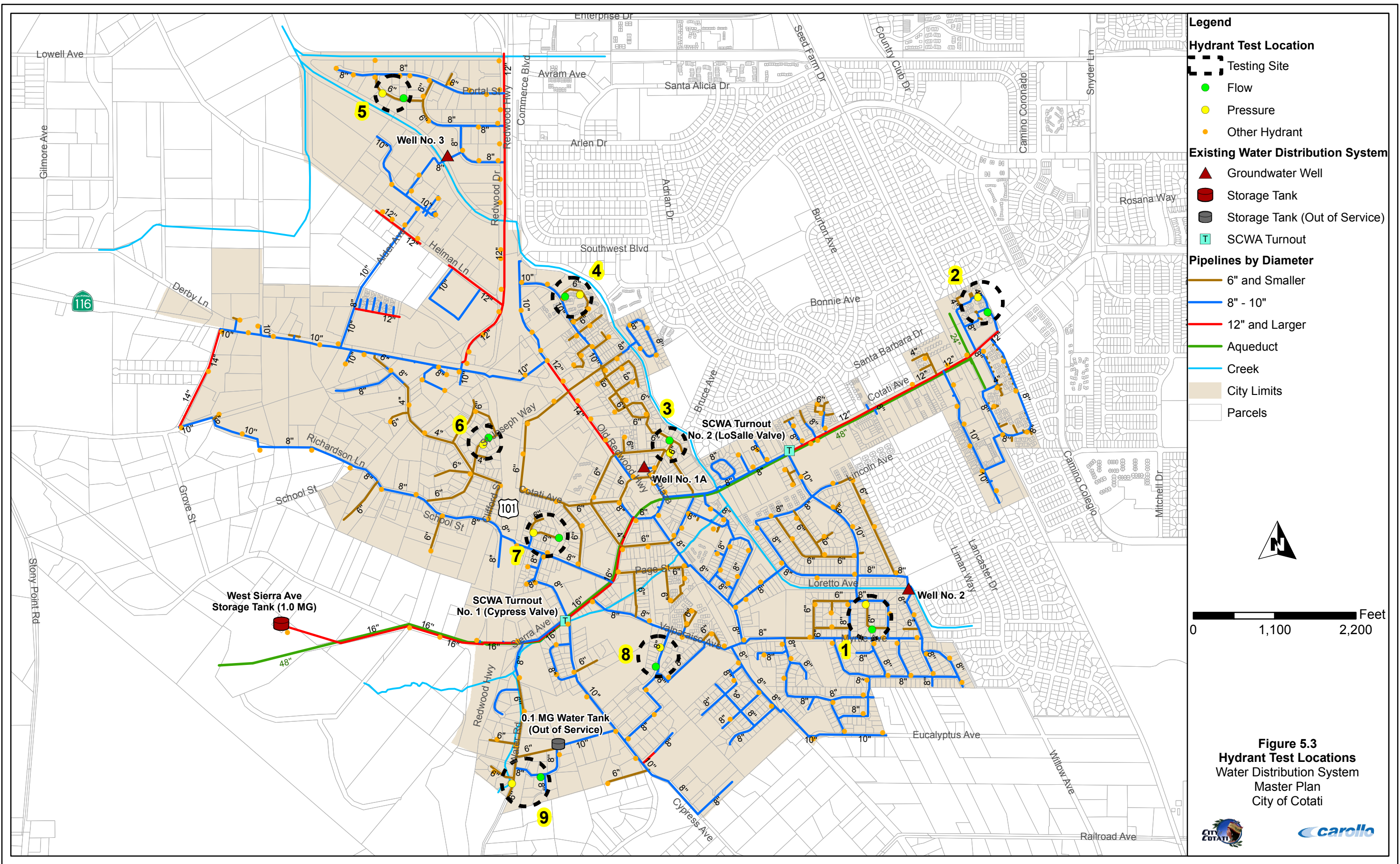
5.3.2 Fire Flow Field Testing

The calibration of fire flow tests is intended to develop a calibrated hydraulic model by closely matching its water model pressures to field pressures under similar demand and system boundary conditions. The primary varied parameter for this calibration is pipeline roughness coefficients; although other parameters can also be adjusted as calibration results are generated.

Hazen-Williams roughness coefficients, or C-factors, have industry accepted value ranges based on pipeline material, diameter, and age. Characteristics specific to the City's distribution system such as water quality, temperature, construction methodologies, material suppliers, and other factors may result in roughness coefficients which differ from

the typical range. Fire Flow calibration refines the initial estimation of the value of roughness coefficients that best indicate conditions of the City's distribution system. During average flow conditions, roughness coefficients have a relatively small effect on operation of the distribution system. As flows increase in the system on higher demand days, velocity within pipelines increase and roughness coefficients contribute more to overall system head loss. Fire Flow tests artificially create high demand events to generate more headloss, allowing a better estimation of the pipeline roughness coefficients.

Fire flow tests for the model calibration were conducted on September 28, 2010 by City staff, the Rancho Adobe Fire District, and Carollo staff. As shown on Figure 5.3, nine fire flow tests were conducted across the City distribution system. Each of these tests consisted of a fire flow test using one flowing hydrant and one pressure hydrant. The tests sites were chosen to provide an adequate representation of system performance throughout the City. An effort was also made to perform the field tests away from large diameter mains (e.g., 12-inch and larger), which do not tend to provide a large enough pressure drop for model calibration.



The fire flow tests stressed the City's distribution system by creating a differential between the HGL at the point of hydrant flow and the system HGL at neighboring hydrants. This HGL differential increased the effect of roughness coefficients on system losses and allowed adjustments to the model to match model pressures to field pressures within an acceptable tolerance (e.g., Hazen-Williams C of ~80-140) in the general vicinity of the field test. As the model was adjusted to match system pressures, roughness coefficients were adjusted only within a tolerance of industry accepted roughness coefficient ranges.

If a model is unable to match the calibration results without leaving the acceptable range of roughness coefficient values for a given pipeline material and age, there would be cause for further investigation of a previously unknown field condition. Examples of such conditions, which typically arise during hydraulic model calibration, include closed pipelines, partially closed or malfunctioning valves, extreme corrosion within pipelines, connectivity and diameter errors in GIS/as-builts, and diurnal patterns of large water users.

5.3.2.1 Fireflow Calibration Results

Numerous simulations were performed during the calibration phase. Adjustments were made to the model between runs to minimize the differences between the model and field results. A detailed summary of the calibration results is shown in Appendix C. The table provided in Appendix C lists the location, time, and results of each field test conducted and corresponding hydraulic model results.

For the monitoring hydrants, the results are considered acceptable if pressures are within 10 psi or have a 10 percent difference to the field data. Model pressures within 5 psi or 5 percent of the field measurements are considered very good. As shown in Table 5.5, all of the computer simulations resulted in pressure differences within about 3 psi or 5 percent of the field measured pressures.

Initial adjustments to the hydraulic model C-factors within industry accepted values did not yield acceptable results for fire test 4, which was conducted on a 6-inch diameter water main located on Creek Court within the Arbor Creek condominium development. The City's AutoCAD map showed that there is a 6-inch and 10-inch loop that extends through the condominium and connects to the 10-inch water main located on Wilford Lane. However, based on the City's record drawings, it was found that the entire length of this pipeline was a 6-inch diameter water main. In addition, based on the findings from the hydraulic modeling, the City was able to locate a closed valve on the 6-inch main, that when closed in the hydraulic model, accounted for the discrepancy in the calibration results for test 4. The City has since opened the value.

With all of the fire test calibration results in the "very good" range, the model was considered calibrated.

Table 5.5 Fire Test Calibration Results Water Distribution System Master Plan City of Cotati										
Test Site	Location	Measured Hydrant Flow ⁽¹⁾ (gpm)	<u>Measured Press.⁽¹⁾</u>		<u>Modeled Press.</u>		<u>Pressure Diff.</u>		<u>Percent Diff.⁽²⁾</u>	
			Static (psi)	Residual (psi)	Static (psi)	Residual (psi)	Static (psi)	Residual (psi)	Static (%)	Residual (%)
1	Flamingo Dr., South of Eagle Dr.	425 - 500	70	65	68.5	65.1	-1.5	+0.1	-2%	+0%
2	Sunflower Dr., North of E. Cotati Ave.	775	68	61	67.1	58.4	-0.9	-2.6	-1%	-4%
3	E. Sierra Ave., East of Arthur St.	650 - 795	70	65	70.1	65.1	+0.1	+0.1	+0%	+0%
4	Creek Ct., near Wilford Ln.	880-890	71	46	73.1	65.6 ³	+1.7	+2.3	+2%	+5%
5	Mercantile Dr., South of Portal St.	975 - 1,000	75	56	74.6	58.0	-0.4	+2.0	+0%	+4%
6	Maple Ave., North of W. Cotati Ave.	900	68	50	66.7	50.9	-1.3	+0.9	-2%	+2%
7	Amber Ln., North of E. School St.	700	55	47	54.6	48.8	-0.4	+1.8	-1%	+4%
8	Lund Hill Ln., South of Valparaiso Ave.	850 - 860	56	52	55.9	51.2	-0.1	-0.8	-0%	-2%
9	Issel Ct., West of Water Rd.	700 - 760	47	40	47.9	40.0	+0.9	+0.0	+2%	+0%
Notes: 1. Field tests were performed on September 28, 2010. Where a range of flows is provided, the average flow was run for model calibration. 2. Percent difference between meter collected and model derived results. 3. The discrepancy was caused by a closed valve in the distribution system, which has since been rectified.										

CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

This section presents the results of the capacity evaluation of the water supply, distribution, and storage facilities. The section also presents improvements to mitigate existing system deficiencies and to serve future users. These improvements are recommended based on the system's technical requirements, cost effectiveness, and reliability.

6.1 SUPPLY ANALYSIS

The additional water supply requirements for the City of Cotati (City) under existing and future demand conditions were determined by comparing the available water supplies with the projected water demands. As noted in Chapter 3, this study recommends that the City maintain a firm water supply capacity equal to the maximum day demand (MDD). Firm capacity is equal to total capacity of the City's groundwater and surface water supplies, minus the capacity of the largest water source. Demands in excess of the MDD (e.g., peak hour demand and fire flow demands) will be met through storage.

The water supply requirements to meet MDD with the largest supply source out of service are presented in Table 6.1. The largest single supply source through year 2035 is the SCWA surface water supply (Allocation limit of 3.8 mgd). As shown in Table 6.1, the system's firm capacity (capacity with SCWA out of service) in 2010 is 2.07 million gallons per day (mgd) compared to a MDD of 2.36 mgd. Because the system's firm capacity is only slightly less than the 2010 MDD, no increase in firm capacity is needed to meet existing system demands. However, as demands increase in the future, an additional well is recommended. Table 6.1 assumes that a new 870 gallons per minute (gpm) well (1.25 mgd, Well 4) will be constructed in year 2012 to accommodate future system demands through year 2035. Figure 6.1 illustrates the information from Table 6.1 in graphical form.

6.2 STORAGE ANALYSIS

The City currently has one active storage tank with a volume of 1.0 million gallons (MG). The purpose of the tank is to provide the City with operational equalization storage to meet peak hour demands (PHDs), fire flow storage (2,500 gpm fire flow for two hours), and emergency storage.

The storage capacity criteria are defined in Chapter 3. Operational equalization storage was defined as 25 percent of the MDD. Emergency storage was defined as 100 percent of the average day demand (ADD). As the City's ADD and MDD increases annually, so does the required storage.

Table 6.1 Water Supply Analysis - Largest Supply Source Out of Service Water Distribution System Master Plan City of Cotati						
Phase/Year		Projected MDD (mgd)	Well Capacity Increase (mgd)	New Well Number	Firm Capacity ⁽¹⁾ (mgd)	Total Supply Capacity ⁽²⁾ (mgd)
Phase 1	2010	2.36			2.07	5.87
	2011	2.38			2.07	5.87
	2012	2.40	1.25	4	3.33	7.13
	2013	2.42			3.33	7.13
	2014	2.44			3.33	7.13
	2015	2.46			3.33	7.13
Phase 2	2016	2.48			3.33	7.13
	2017	2.49			3.33	7.13
	2018	2.51			3.33	7.13
	2019	2.52			3.33	7.13
	2020	2.54			3.33	7.13
Phase 3	2021	2.58			3.33	7.13
	2022	2.62			3.33	7.13
	2023	2.66			3.33	7.13
	2024	2.70			3.33	7.13
	2025	2.74			3.33	7.13
Phase 4	2026	2.80			3.33	7.13
	2027	2.85			3.33	7.13
	2028	2.90			3.33	7.13
	2029	2.96			3.33	7.13
	2030	3.01			3.33	7.13
Phase 5	2031	3.05			3.33	7.13
	2032	3.09			3.33	7.13
	2033	3.13			3.33	7.13
	2034	3.18			3.33	7.13
	2035	3.22			3.33	7.13
Notes: 1. Firm Capacity is the City's total supply capacity with the largest single source of supply out of service. In the case of the City, the largest source of supply is the City's SCWA supply. 2. Total supply capacity includes maximum SCWA allotment (3.8 mgd) 2. Firm capacity is the total of the City's existing well capacity. The firm capacity was calculated using the mid point of the Well 1A booster station capacity (360 gpm).						

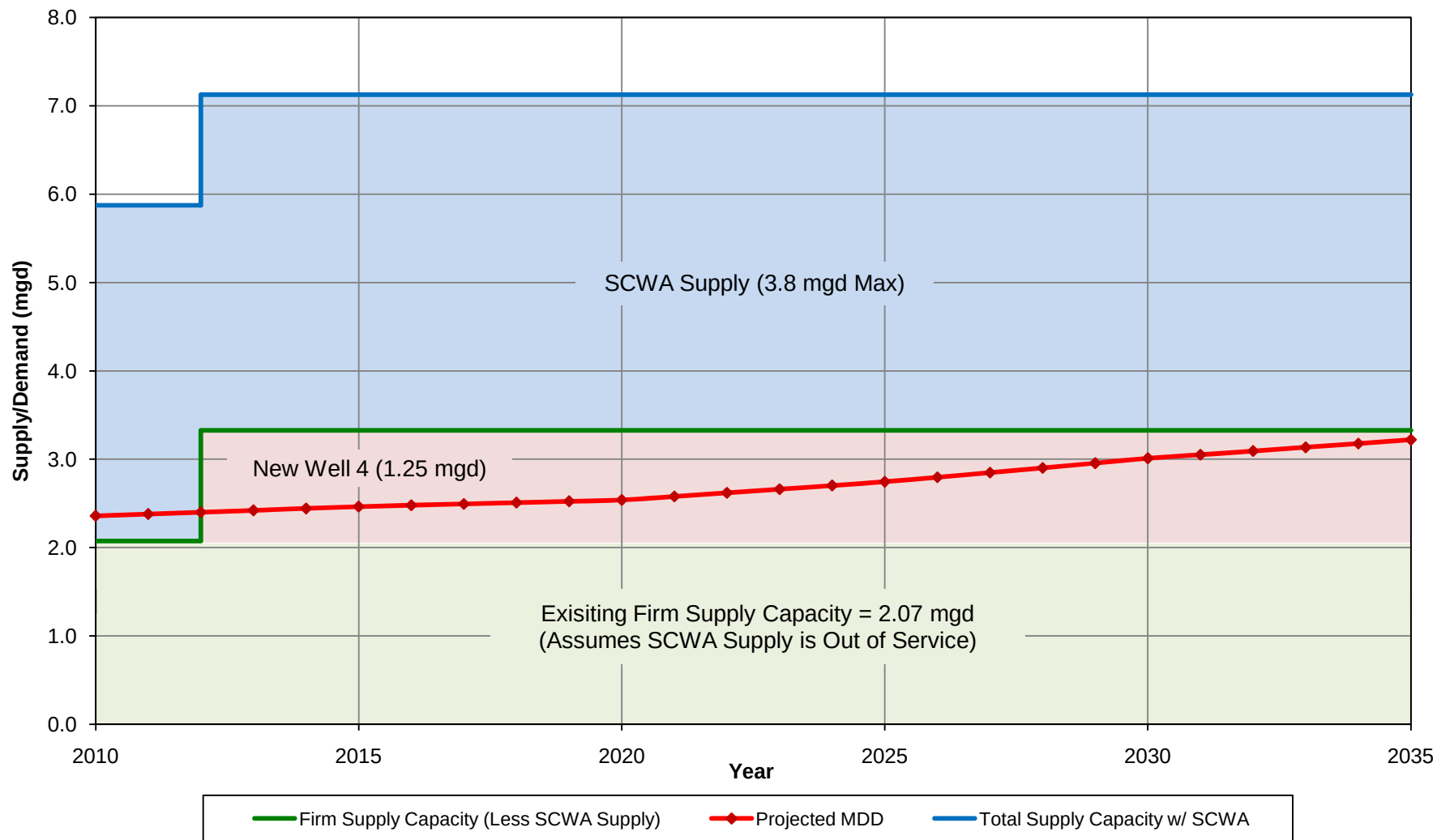


Figure 6.1
Increase in Demand and Supply
 Water Distribution System Master Plan
 City of Cotati

It is possible that the City may be able to utilize a portion of the City's SCWA storage allotment in the event of an emergency. However, based on information provided by SCWA, it is unclear as to whether the City would be able to reasonably depend on water from the SCWA tanks during emergencies. For this reason, it is recommended that the City plan on providing enough storage capacity within its own distribution system to meet the required storage without reliance on the SCWA storage allotment. Based on this assumption, the required storage through year 2035 is calculated in Table 6.2. As shown in Table 6.2, the City's existing storage reservoir by itself is not sufficient to meet the existing operational equalization, fire flow, and the emergency storage requirements. This analysis did not include an evaluation of water age in the distribution system.

Two additional storage tanks are recommended to provide adequate storage capacity within the City distribution system for existing and future demand conditions. The City is planning to construct a 400,000 gallon tank at the site of the existing Cypress Storage Tank and demolish the existing tank. Unfortunately, the new Cypress Tank is not sufficient to provide the required storage volume to meet existing and future capacity requirements. Therefore, an additional 1.0 MG tank is recommended, which in combination with the new Cypress Avenue Tank, would increase the City's total storage capacity to 2.4 MG and provide the City with adequate storage to build out (year 2035).

Similar to Figure 6.1, Figure 6.2 illustrates the required increase in storage capacity through 2035. The figure shows the step increase in storage capacity with the installation of new storage tanks.

6.3 DISTRIBUTION SYSTEM ANALYSIS

This section presents results of system pressure analysis, fire flow analysis, and pipeline velocity analysis for the City's water distribution system. Recommendations to address identified deficiencies are presented in the Section 6.4.

6.3.1 System Pressure Analysis

In accordance with the criteria summarized in Chapter 3, system pressure analyses were performed using the hydraulic model for MDD, PHD, and MDD with fire flow conditions. This section summarizes the results of the analysis for existing and future demand conditions.

6.3.1.1 Existing System

For each demand condition (i.e., MDD, PHD, and MDD+FF), the hydraulic model was used to identify service nodes within the distribution system with pressures that violate the established pressure criteria (Per Table 4.4). The analysis was performed for a number of scenarios in which different supply sources in the City are assumed to be out of service.

Table 6.2 Storage Capacity Analysis Water Distribution System Master Plan City of Cotati										
Phase/Year		Projected ADD (mgd)	Projected MDD (mgd)	Storage Criteria				Storage Capacity Increase		
				Operational Equalization Storage, 25% of MDD (MG)	+ Fire Flow Storage, 2,500 gpm for 2 hrs. + (MG)	Emergency Storage, 100% of ADD (MG)	= Total Required Storage (MG)	Total Storage Capacity Increase (MG)	New Tank Name	Total Storage Capacity ⁽¹⁾ (MG)
Phase 1	2010	0.98	2.36	0.59	0.30	0.98	1.87			1.00
	2011	0.99	2.38	0.59	0.30	0.99	1.89			1.00
	2012	1.00	2.40	0.60	0.30	1.00	1.90	0.40	New Cypress Tank	1.40
	2013	1.01	2.42	0.61	0.30	1.01	1.91			1.40
	2014	1.02	2.44	0.61	0.30	1.02	1.93			1.40
	2015	1.03	2.46	0.62	0.30	1.03	1.94			1.40
Phase 2	2016	1.03	2.48	0.62	0.30	1.03	1.95	1.00	West Sierra Tank 2	2.40
	2017	1.04	2.49	0.62	0.30	1.04	1.96			2.40
	2018	1.05	2.51	0.63	0.30	1.05	1.97			2.40
	2019	1.05	2.52	0.63	0.30	1.05	1.98			2.40
	2020	1.06	2.54	0.63	0.30	1.06	1.99			2.40
Phase 3	2021	1.07	2.58	0.64	0.30	1.07	2.02			2.40
	2022	1.09	2.62	0.65	0.30	1.09	2.05			2.40
	2023	1.11	2.66	0.67	0.30	1.11	2.07			2.40
	2024	1.13	2.70	0.68	0.30	1.13	2.10			2.40
	2025	1.14	2.74	0.69	0.30	1.14	2.13			2.40
Phase 4	2026	1.16	2.80	0.70	0.30	1.16	2.16			2.40
	2027	1.19	2.85	0.71	0.30	1.19	2.20			2.40
	2028	1.21	2.90	0.73	0.30	1.21	2.23			2.40
	2029	1.23	2.96	0.74	0.30	1.23	2.27			2.40
	2030	1.25	3.01	0.75	0.30	1.25	2.31			2.40
Phase 5	2031	1.27	3.05	0.76	0.30	1.27	2.33			2.40
	2032	1.29	3.09	0.77	0.30	1.29	2.36			2.40
	2033	1.31	3.13	0.78	0.30	1.31	2.39			2.40
	2034	1.32	3.18	0.79	0.30	1.32	2.42			2.40
	2035	1.34	3.22	0.81	0.30	1.34	2.45			2.40
Notes: 1. Storage capacity analysis assumes that in the event of an emergency, such as an earthquake, excess SCWA storage capacity will not be available to the City.										

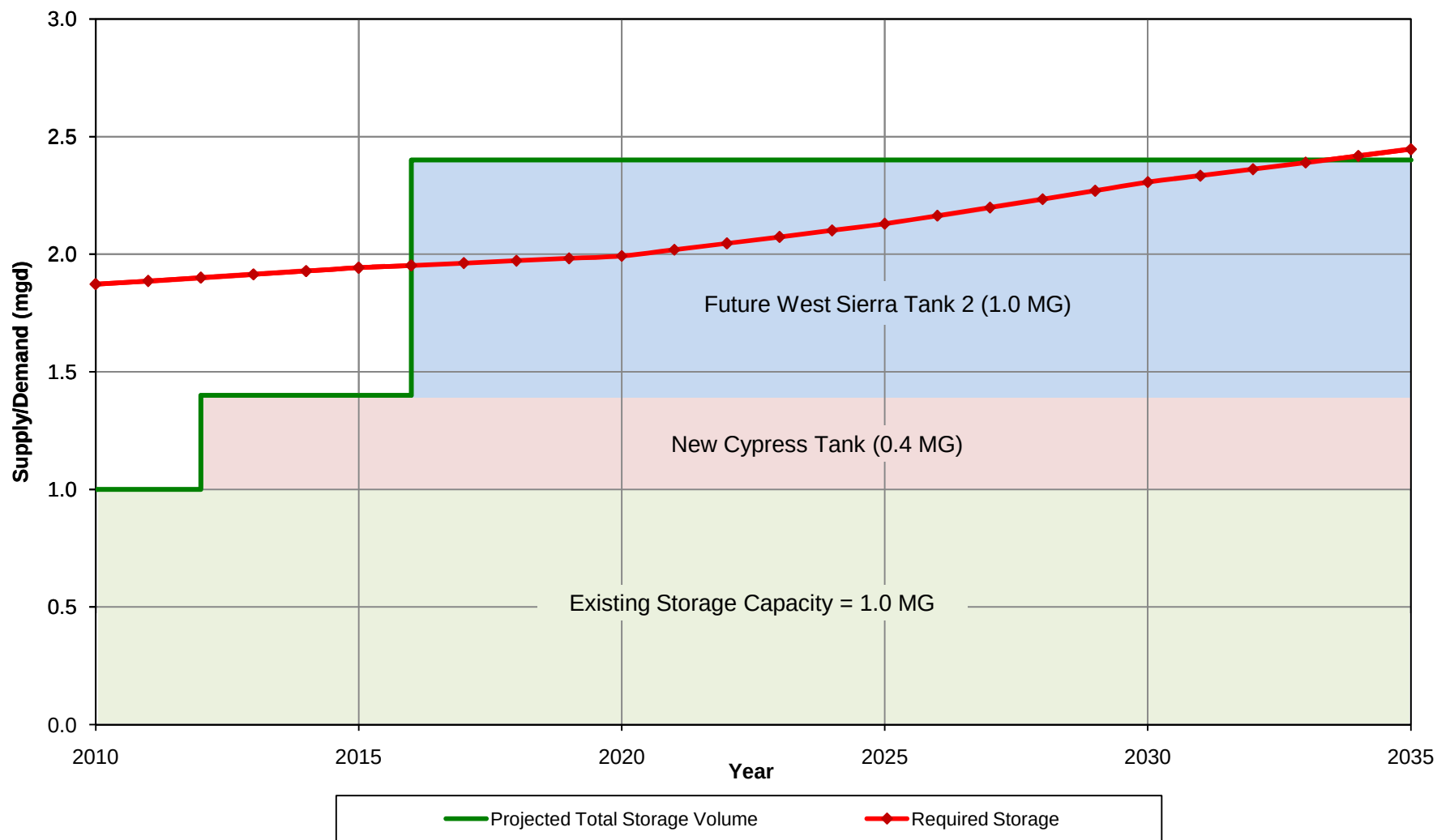


Figure 6.2
Required Storage Capacity
Water Distribution System Master Plan
City of Cotati

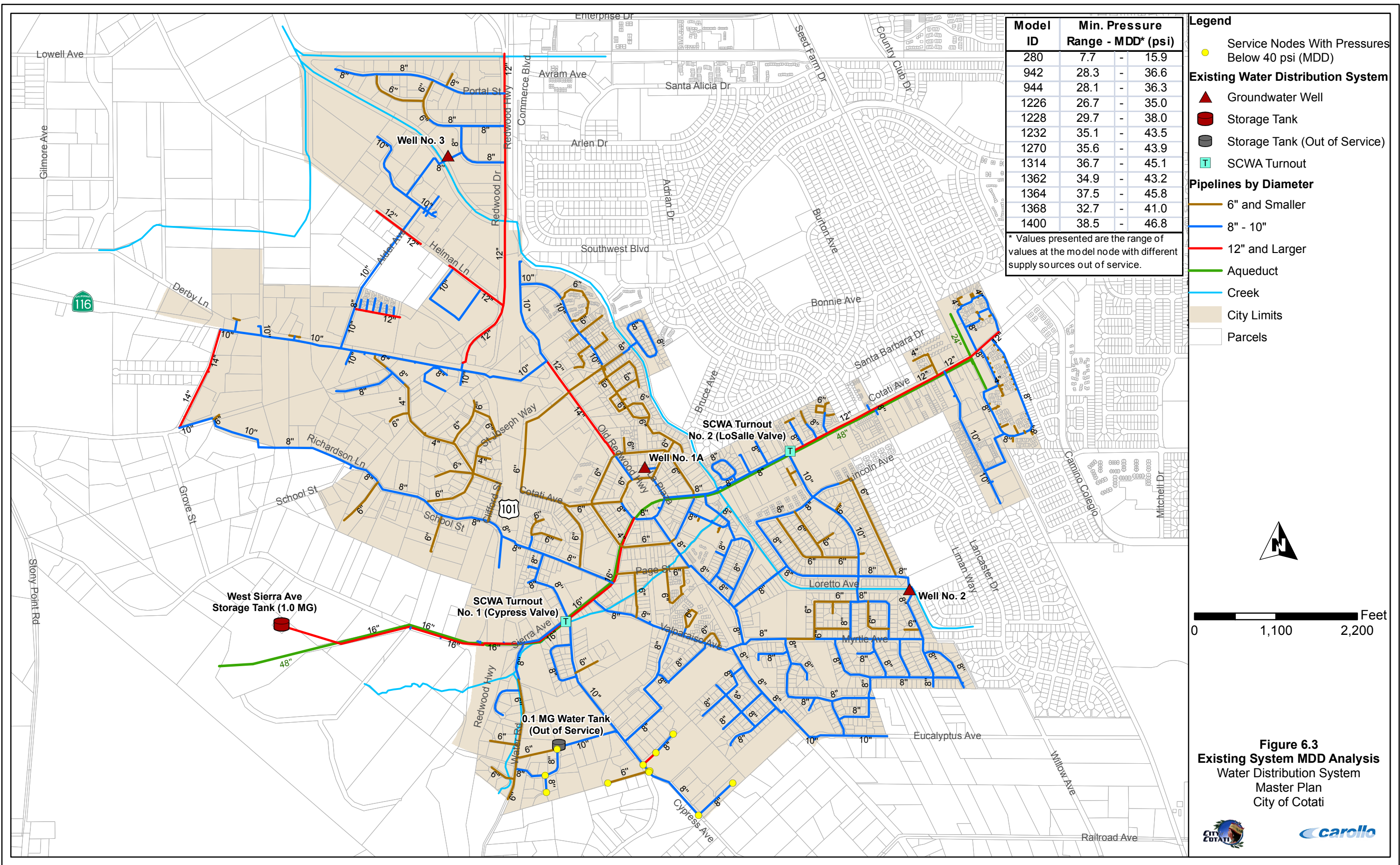
The scenarios that were evaluated as part of the analysis are listed below:

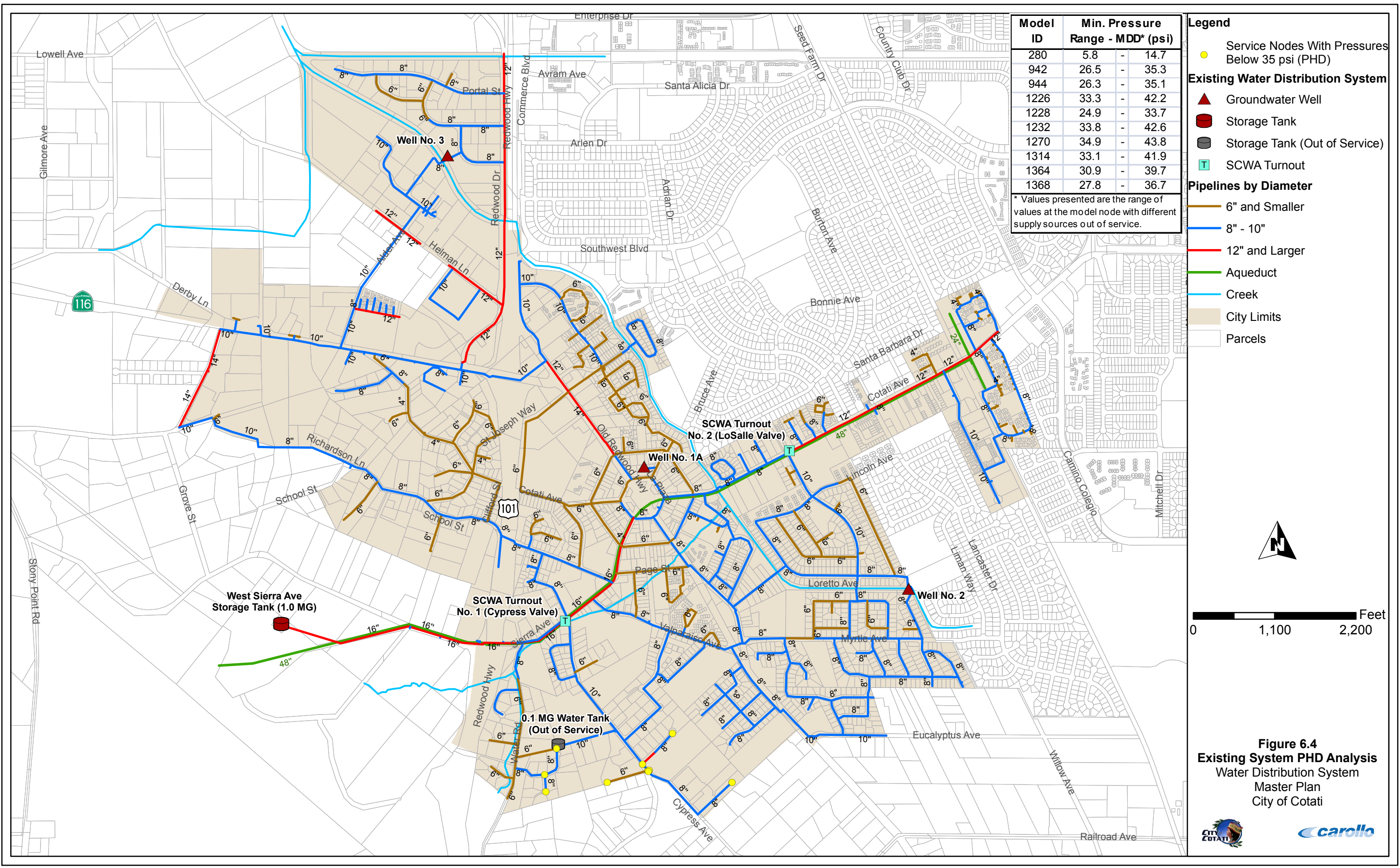
- Scenario 1 – All Supply Sources Active
- Scenario 2 – SCWA Turnout 1 Out of Service
- Scenario 3 – SCWA Turnout 2 Out of Service
- Scenario 4 – Well 1 Out of Service
- Scenario 5 – Well 2A Out of Service
- Scenario 6 – Well 3 Out of Service
- Scenario 7 – SCWA Turnout 1 and 2 Out of Service

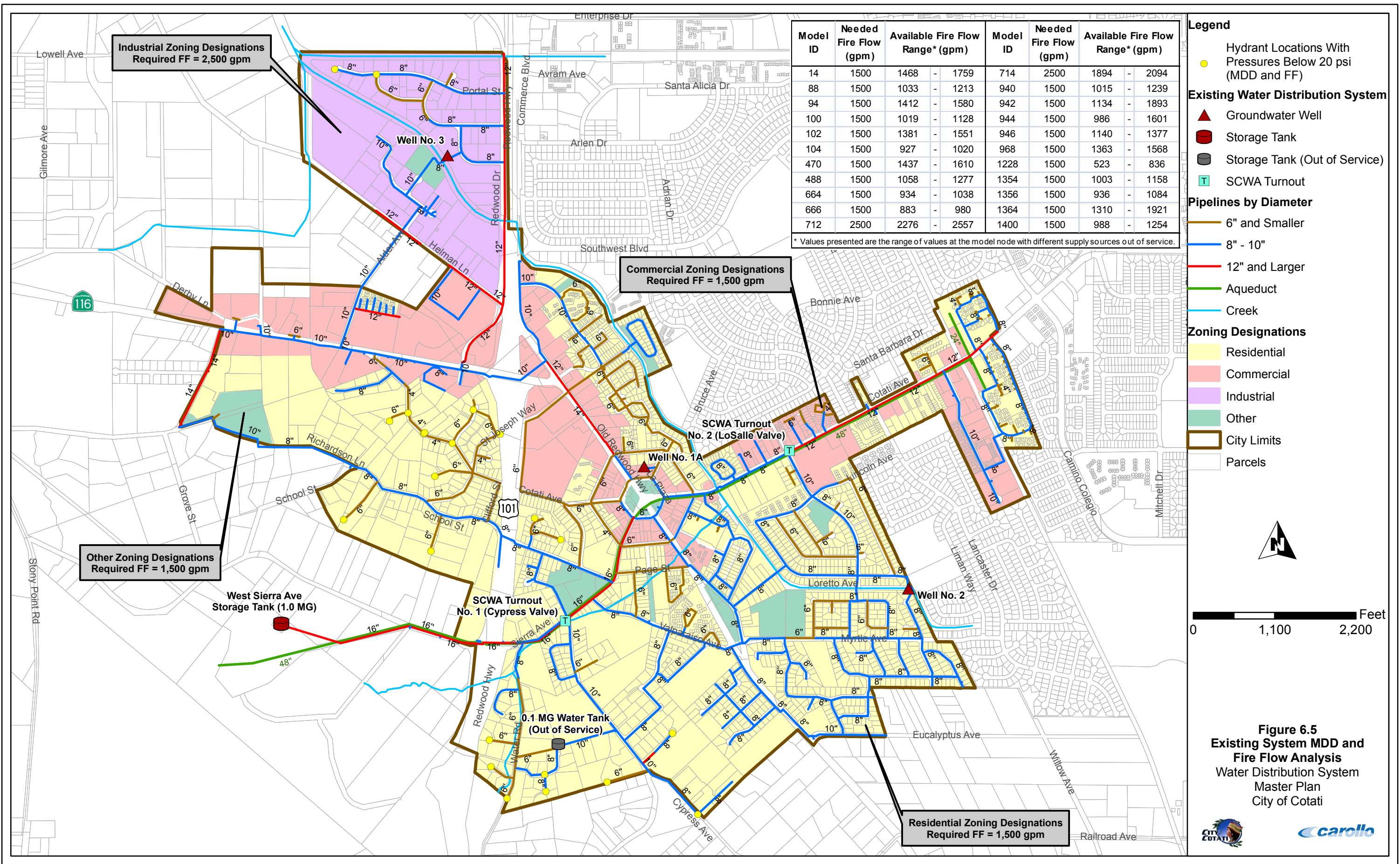
Based on these assumptions, the following is noted:

- Maximum Day Demand: The hydraulic modeling results for existing MDD conditions showed that 12 service nodes had pressures that violated the minimum pressure criteria of 40 pounds per square inch (psi). The locations of these nodes are shown on Figure 6.3. The deficient service nodes are all located in the vicinity of the inactive Cypress Tank. According to City staff, residences Loma Linda Lane are currently equipped with individual booster pumps to ensure adequate pressure at the service connection.
- Peak Hour Demand: Similar to the existing MDD analysis, the locations of the service nodes that had pressures that violated the minimum pressure criteria of 35 psi under PHD conditions are all located in the vicinity of the inactive Cypress Tank. As shown on Figure 6.4, the hydraulic modeling results showed that 10 service nodes violated the 35-psi pressure criteria. However, as noted above, residences on Loma Linda Lane are equipped with individual booster pumps.
- Maximum Day Demand plus Fire Flow: Hydraulic modeling results for MDD plus fire flow conditions showed that 22 hydrant nodes had residual pressures less than the minimum residual pressure criteria of 20 psi. The locations of these nodes are shown on Figure 6.5.

Many of the deficient nodes are located in the vicinity of the inactive Cypress Tank. These deficiencies are chiefly caused by the high service elevations in this area, as well as small pipelines that are incapable of providing the required fire flow. As noted above, there are individual booster pumps for customer Loma Linda Lane. However, in the event of a fire, the nodes identified in Figure 6.5 in the vicinity of the Cypress Tank will still be incapable of providing the minimum residual pressure.



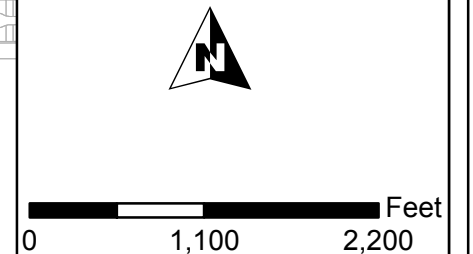




Model ID	Needed Fire Flow (gpm)	Available Fire Flow Range* (gpm)		Model ID	Needed Fire Flow (gpm)	Available Fire Flow Range* (gpm)	
14	1500	1468	-	1759	714	2500	1894 - 2094
88	1500	1033	-	1213	940	1500	1015 - 1239
94	1500	1412	-	1580	942	1500	1134 - 1893
100	1500	1019	-	1128	944	1500	986 - 1601
102	1500	1381	-	1551	946	1500	1140 - 1377
104	1500	927	-	1020	968	1500	1363 - 1568
470	1500	1437	-	1610	1228	1500	523 - 836
488	1500	1058	-	1277	1354	1500	1003 - 1158
664	1500	934	-	1038	1356	1500	936 - 1084
666	1500	883	-	980	1364	1500	1310 - 1921
712	2500	2276	-	2557	1400	1500	988 - 1254

* Values presented are the range of values at the model node with different supply sources out of service.

- Legend**
- Hydrant Locations With Pressures Below 20 psi (MDD and FF)
 - Existing Water Distribution System**
 - Groundwater Well
 - Storage Tank
 - Storage Tank (Out of Service)
 - SCWA Turnout
 - Pipelines by Diameter**
 - 6" and Smaller
 - 8" - 10"
 - 12" and Larger
 - Aqueduct
 - Creek
 - Zoning Designations**
 - Residential
 - Commercial
 - Industrial
 - Other
 - City Limits
 - Parcels



To address this issue, it is recommended that the City install a new fire flow booster pump station, as well as the appropriate distribution system piping necessary to create a boosted fire flow zone in the event of a fire. More discussion regarding the recommended boosted fire flow zone is provided in Section 6.4.

The remaining deficiencies are located in areas of the City where the distribution system pipelines are not adequately sized to convey the required fire flow. In some instances, there are dead end pipes in the system that is not large enough to convey the required fire flow.

6.3.1.2 Future System

Following the completion of the existing system analysis, improvement projects were identified in order to mitigate existing system pressure deficiencies. The recommended improvements are discussed in Section 6.4. In addition to the improvements to mitigate existing deficiencies, future system pipelines were added to the model to complete loops in areas that will develop in the future (see Section 6.4). The future system scenarios were developed by applying the water generation coefficients summarized in Table 4.1 to the vacant lands within the study area. The new water demands are allocated into the model to simulate the build-out condition. For this Master Plan the Build-out and Future System are synonyms and are used interchangeably.

The future system analysis was performed in a manner similar to the existing system analysis. The purpose of the future system evaluation is to verify that the future system pipelines to complete loops in undeveloped areas are appropriately sized, and that the build out water demands do not create additional deficiencies within the existing distribution system that cannot be corrected by implementing the recommended existing system improvement projects.

Based on the hydraulic modeling results of the future water distribution system, no additional pressure deficiencies were observed under future MDD, PHD, or MDD plus fire flow conditions with the recommended existing system improvements.

6.3.2 Pipeline Velocity Analysis

Pipeline velocity analyses were performed based on the criteria provided in Chapter 3 using the hydraulic model for both MDD and PHD conditions. This section summarizes the results of the analysis for existing and future demand conditions.

6.3.2.1 Existing System

The pipeline velocity analysis was performed for a number of scenarios in which different supply sources in the City are assumed to be out of service. For each demand condition (i.e., MDD, PHD), the hydraulic model was used to identify pipelines within the distribution system with velocities or headlosses that violate the criteria provided in Chapter 3.

Based on the results of the existing system pipeline analysis, the following is noted:

- Maximum Day Demand: The hydraulic modeling results for existing MDD conditions revealed no velocity deficiencies within the existing water distribution system under existing MDD conditions.
- Peak Hour Demand: Similar to the existing MDD analysis, the hydraulic modeling results showed no velocity deficiencies within the existing water distribution system.

6.3.2.2 Future System

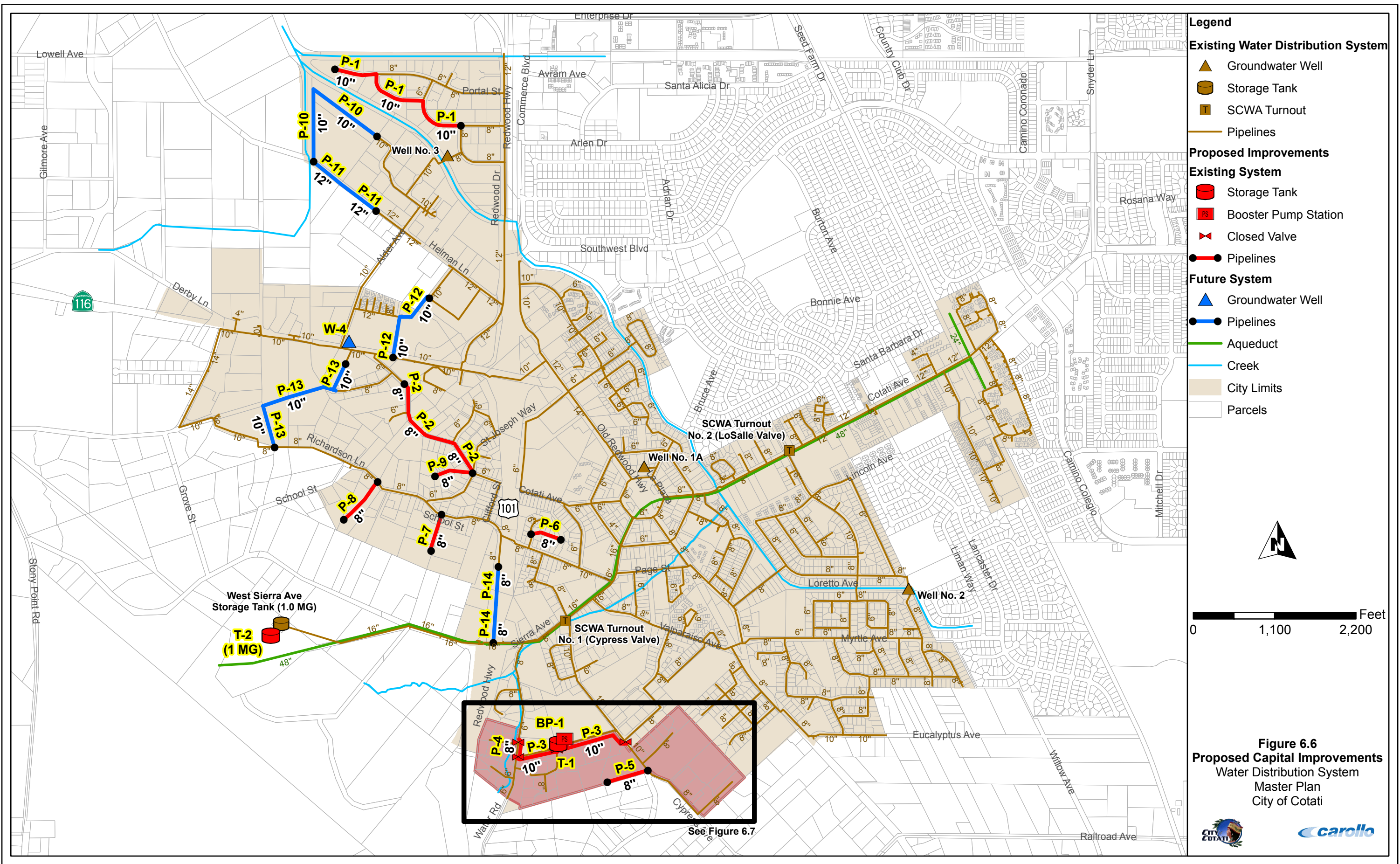
Based on the hydraulic modeling results of the future water distribution, no additional pipeline velocity or headloss deficiencies were observed under future MDD or PHD conditions with the recommended existing system improvements.

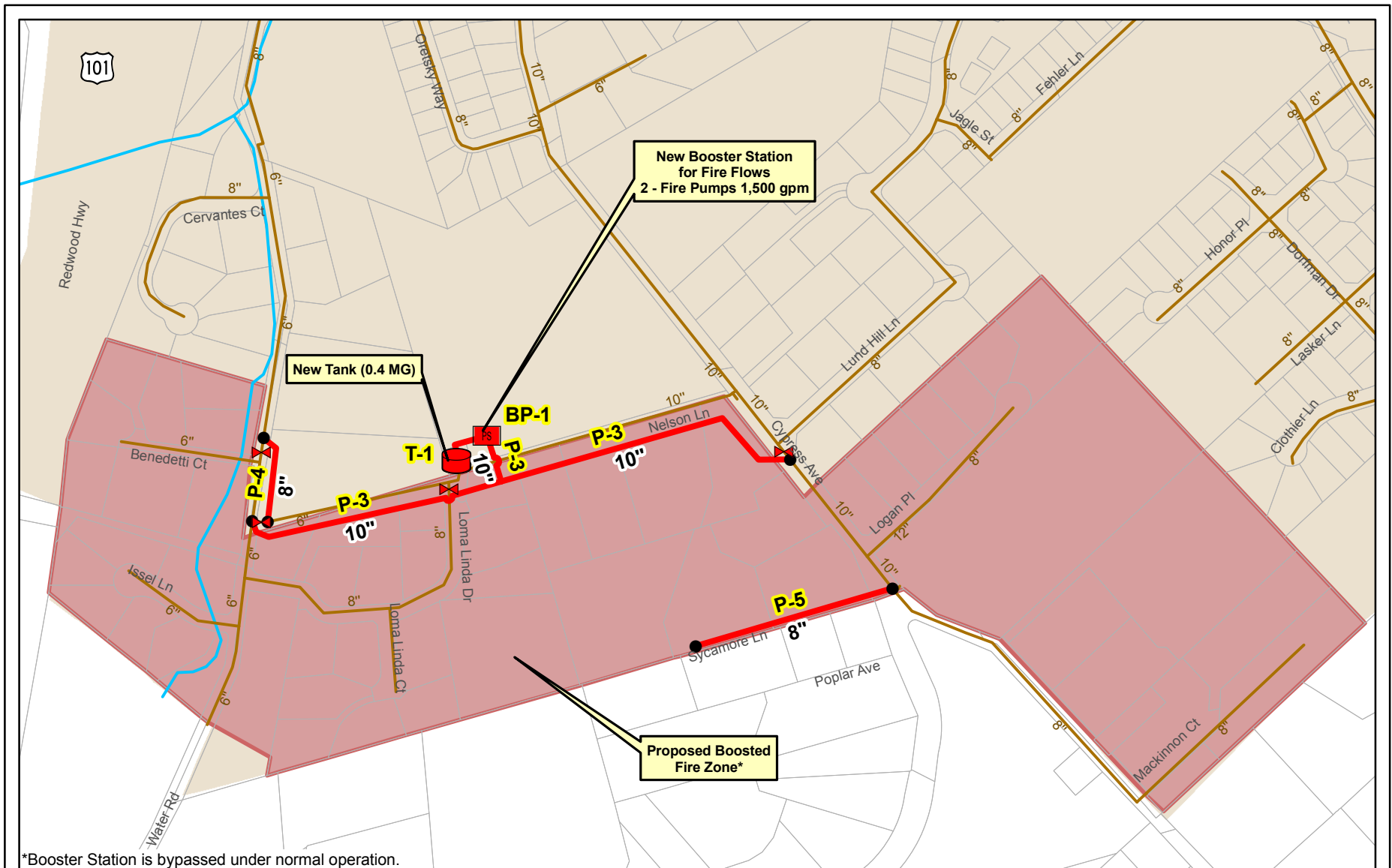
In addition, the future system pipelines were checked against the pipeline velocity and headloss criteria provided in Chapter 3 to verify that the future system pipelines were appropriately sized.

6.4 DISTRIBUTION SYSTEM IMPROVEMENTS

Figure 6.6 provides a graphical illustration of the improvements recommended to mitigate capacity deficiencies in the existing water system and the improvements to meet future demand as identified by the hydraulic analysis. A detail map for the proposed improvements in the vicinity of the Cypress tank are provided in Figure 6.7 for clarity. The improvements are summarized in Table 6.3 with a cross-referenced number system. The columns used in Table 6.3 refer to the following:

- **Figure Number**: Assigned number that corresponds to the Proposed Improvements Table. This is an alphanumeric number that starts with one letter indicating the type of improvement P= Pipe, T = Tank, W = Well, BP = Booster Pump and continues with a number.
- **Type of improvement**: Storage tanks, wells, pipelines, jacked steel casings, and booster pumps.
- **Street Description**: Street in which the improvement is proposed.
- **Limits**: Description of the beginning and end of a proposed pipeline project.
- **Ex. Size/Diameter**: This is the size of the existing pipeline/facility. It represents the diameter of the existing pipelines (in inches), the size of the storage reservoirs (in MG), and the size of the wells and booster stations (in gpm).
- **New Size/Diameter**: This is the size of the proposed improvement. It represents the diameter of the proposed pipelines (in inches), the size of the storage tanks (in MG), and the size of the wells and booster stations (in gpm).
- **Additionally**, for jacked steel casings, the size of the casing as well as the carrier pipe is indicated (in inches).





Legend

Existing Water Distribution System

Pipelines

Proposed Improvements

Existing System

Storage Tank

Booster Pump Station

Valves to Close

Pipelines

New Boosted Fire Zone

Creek

Parcels



0 250 500 Feet

Figure 6.7
Proposed Improvement Projects to Create
New Boosted Fire Zone
Water Distribution System Master Plan
City of Cotati



Table 6.3 Proposed Water Distribution System Improvements Water Distribution System Master Plan City of Cotati														
Figure No.	Type of Improvement	Description/ Street	Description / Limits	Improv. Category	Project Length/Size				Capital Improvement Phasing					
					Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Phase 1 2011-2015	Phase 2 2017-2021	Phase 3 2022-2026	Phase 4 2027-2031	Phase 5 2032-2036	
Existing System Improvements														
Pipelines														
P-1	Pipe	Portal Street, Mercantile Drive, Aaron Street	From Portal Street to Houser Street	Category 2	6/8	10	Replace	2,100	Phase 1					
P-2	Pipe	West Cotati Avenue	From Gilman Ranch Road to Maple Avenue	Category 2	4	8	Replace	1,700	Phase 1					
P-3	Pipe	Nelson Road	Adjacent to the Existing Cypress Tank (Cypress to Water Road)	Category 2	-	10	New	1,900	Phase 1					
P-4	Pipe	Water Road	Adjacent to the Existing Cypress Tank (Loma Linda to Benedetti)	Category 2	-	8	Replace	200		Phase 2				
P-5	Pipe	Sycamore Lane	West of Cypress Avenue	Category 3	6	8	Replace	600		Phase 2				
P-6	Pipe	Amber Lane	East of Woodland Hills Drive	Category 3	6	8	Replace	400		Phase 2				
P-7	Pipe	Oak Circle	South of West School Street	Category 3	6	8	Replace	500		Phase 2				
P-8	Pipe	Un-named Street off of West School Street	South of West School Street	Category 3	6	8	Replace	700		Phase 2				
P-9	Pipe	Un-named Street off of West Cotati Avenue	West of West Cotati Avenue	Category 3	6	8	Replace	500		Phase 2				
Storage Tanks and Booster Pumps														
T-1	Storage Tank	New Cypress Storage Tank	At Existing Cypress Tank Site	Category 1	-	0.4 MG	New	-	Phase 1					
T-2	Storage Tank	West Sierra Water Storage Tank 2	Adjacent to Existing West Sierra Tank Site	Category 1	-	1 MG	New	-		Phase 2				
	Land Acquisition	West Sierra Water Storage Tank 2	Adjacent to Existing West Sierra Tank Site	Category 1	-	0.8 acres	New	-	Phase 1					
BP-1	Booster Pump	Cypress Booster Pumps	Adjacent to New Cypress Tank	Category 1	-	3,000 gpm	New	-	Phase 1					
Future System Improvements														
Pipelines														
P-10	Pipe	Blodgett Street, west, Loop back to Helman	Blodgett Street West to Creek, then South parallel to creek	Category 4	-	10	New	1,200				Phase 3		
P-11	Pipe	Helman Lane	From P-10 to Existing 12" stub in Helman	Category 4	-	12	New	1,000				Phase 3		
P-12	Pipe	Near Ford Lane	Interconnect Helman, Ford and Gravenstein Highway	Category 4	-	10	New	1,100					Phase 4	
P-13	Pipe	Near Gilman Ranch Road	From Gilman Ranch Road to Richardson Lane	Category 4	-	10	New	2,000					Phase 4	
P-14	Pipe	West School Street	West School Street to West Sierra Avenue	Category 4	-	8	New	1,000						Phase 5
Groundwater Wells														
W-4	Supply Well ⁽³⁾	Future Well 4	Intersection of Gravenstein Highway and Alder Avenue	Category 1	-	1.25 mgd	New	-	Phase 1					

- **Length:** Estimated length of the proposed improvement (in feet). It should be noted that the length estimates do not account for re-routing the alignment to avoid unknown conditions.

6.4.1 Project Categories

The proposed projects provide the City with a list of improvements that will correct capacity deficiencies in the distribution system that could occur during peak demand conditions or during fire flow events. When fully implemented, the capital projects will enhance the distribution of water during maximum demand conditions to existing and future users.

Each improvement project listed in Table 6.3 was grouped into one of four different categories, based on the type of deficiency that is meant to be addressed by the improvement. The four categories are discussed below:

- **Category 1: Supply/Storage Improvements to Meet CDPH Standards.** Proposed supply and storage improvements that are primarily needed to meet the California Department of Public Health (CDPH) standards were grouped into Category 1. These improvements also benefit the City's ability to provide needed fire flow throughout the City. The predominant driving factor behind these improvements, however, is meeting the CDPH standards for supply and storage.
- **Category 2: Network Improvements to Provide Needed Fire Flow.** Pipeline and booster pump station improvements required to provide the needed fire flow within the main distribution system network were grouped into Category 2. The improvements generally address fire flow deficiencies in large blocks of the City (e.g., not at a single hydrant on a dead end main).
- **Category 3: Dead End Pipe Improvements to Provide Needed Fire Flow and to Meet AWWA Standards.** The City's water distribution system includes dead end pipelines to service individual cul-de-sacs and residences in the City. Many of these pipelines are 6-inches in diameter and smaller, and are not adequately sized to provide the needed fire flow at hydrant locations on the dead end mains. The American Waterworks Association (AWWA) Manual M31 provides minimum standards for dead end piping with hydrants. According to Manual M31, dead end piping should have a minimum diameter of 8-inches.

Category 3 improvements are defined as pipeline improvements that are required to provide the needed fire flow in dead end water mains 6-inches in diameter and smaller. It should be noted that the Category 3 improvements include only dead end mains that cannot provide the needed fire flow. Recognizing that it is impractical to replace all dead end 6-inch diameter mains, dead end mains that can provide the needed fire flow were not targeted for replacement as part of this study.

- **Category 4: Improvements to Provide Main Looping in Future Development Areas.** System improvements exclusively required to provide distribution system looping in vacant areas within the City limits were targeted as Category 4 improvements.

6.4.2 Existing Versus Future Improvement

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to meet fire flow criteria) for existing users. If a project was proposed to exclusively correct an existing deficiency, then existing users were assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.

Future growth will trigger the construction of new facilities to support this growth (e.g., new distribution system pipelines to serve vacant areas within the City service area). If a specific project is needed to serve future growth exclusively, the future users were assigned 100 percent of the future project's benefit and 100 percent of the costs.

In some cases, such as a proposed storage tank, projects are needed to mitigate existing deficiencies and to accommodate future growth. Where a project is needed to mitigate existing deficiencies and serve future growth, the future user benefit was determined based on the additional capacity necessary to serve future growth. More information on the breakdown in cost split between existing and future users and whether a proposed improvement is intended to correct an existing deficiency, to serve a future user, or both is provided in Chapter 7.

6.4.3 Well Improvements

The supply capacity analysis indicated that the City's existing firm supply capacity is approximately 2.07 mgd, compared to an existing MDD of roughly 2.36 mgd. Therefore, the City's existing MDD is very close to the existing firm capacity. Since the existing firm capacity is very close to the MDD, additional supply sources will be needed to serve future demands generated by development. It is recommended that the City construct one additional groundwater well to accommodate future growth. Based on the supply capacity analysis, it is recommended that the City install future Well 4 (Improvement Number W-4), with a capacity of roughly 870 gpm (1.25 mgd). This is a Category 1 improvement. With the installation of Well 4, the City will have enough firm capacity to provide supply through build out (year 2035).

6.4.4 Tank Improvements

The storage capacity analysis indicated that the City currently has a storage deficiency of 0.87 MG. Therefore, additional storage tanks are recommended. The City is planning to construct a new 400,000 gallon storage tank at the site of the existing inactive Cypress Tank (Improvement Number T-1). This is a Category 1 improvement. Construction of this tank would decrease the existing storage capacity deficit to roughly 0.47 MG.

To fully mitigate the existing storage deficiency and to service future growth, it is recommended that an additional, 1.0 MG tank be constructed. For budgeting purposes, this Master Plan assumes that the new 1.0 MG tank (Improvement Number T-2) will be constructed adjacent to the existing West Sierra Tank site. This is also a Category 1 improvement.

6.4.5 Fire Flow Booster Pump/Rezoning Improvements

In order to provide adequate service pressures and to meet the required fire flows in the vicinity of the inactive Cypress Tank, it is recommended that the City create a new boosted fire zone to serve this area. The new boosted fire zone would be configured in a manner shown on Figure 6.7. The new pressure zone would require the installation of a new booster pump station (Improvement No. BP-1) adjacent to the proposed 400,000 gallon Cypress Tank (Improvement No. T-1). The new Cypress Booster Pump Station would consist of two 1,500 gpm fire pumps to provide the required fire flow while meeting the minimum 20 psi residual requirement.

The Cypress Booster Pump Station will pump water from the new 400,000-gallon Cypress Tank into the boosted pressure zone. Additional pipelines are also recommended (Improvement Numbers P-3 and P-4) to create loops in both the City's main pressure zone and the new boosted fire zone. Figure 6.7 also shows the locations of valves to close in order to isolate the proposed boosted zone from the City's main pressure zone.

Under normal operating conditions, the Cypress Booster Pump Station will remain inactive and water will be allowed to bypass the pump station via a bypass pipeline and valve at the pump station. The three valves shown on Figure 6.7 would remain closed under all operating conditions. During a fire flow, the bypass valve at the booster pump station would close (isolating the boosted fire zone from the City's main pressure zone) and one (or more if necessary) of the fire pumps would turn on to provide the needed fire flow. In essence, system pressures in the new zone will be essentially unchanged from the existing configuration under normal operating conditions. The only time that the new zone would be "boosted" would be under fire flow conditions.

The fire flow booster pump station/rezoning improvements are Category 2 improvements.

6.4.6 Pipeline Improvements

Based on the results of the existing and future system pressure and pipeline velocity analysis, the following projects are recommended:

- **Existing System Improvements**
 - Improvement Number P-1: It is recommended that the City replace the existing 6-inch and 8-inch diameter water main on Aaron Street, Mercantile Drive, and Portal Street with a 10-inch diameter water main in order to meet the required 2,500 gpm fire flow for this industrial zoning area. This is a Category 2 improvement.

- Improvement Number P-2: To meet the required 1,500 gpm fire flow for the area near West Cotati Avenue west of Highway 101 and south of Highway 116, it is recommended that the existing 4-inch diameter water main on West Cotati Avenue from Maple Avenue to west of Cohen Court be replaced with a new 8-inch diameter water main. This is a Category 2 improvement.
- Improvement Number P-3 and P-4: Construct a new 10-inch diameter and 8-inch diameter water mains near the proposed 400,000 gallon Cypress Tank (Improvement Number T-1) to create a new boosted fire zone as described in Section 6.4.5 (Improvement Number BP-1). These pipelines are grouped as Category 2 improvements.
- Improvement Number P-5 through P-9: Replace various dead end 6-inch diameter water mains throughout the City with 8-inch diameter water mains to meet the required fire flow criteria. These are Category 3 improvements.
- **Future System Improvements**
 - Improvement Number P-10 through P-14: Construct various 8-inch, 10-inch, and 12-inch diameter water mains to connect loops within currently undeveloped areas within the City. These are Category 4 improvements.

CAPITAL IMPROVEMENT PLAN

This section presents the recommended capital improvement plan (CIP) for the City of Cotati (City) water distribution system and a summary of the capital costs. This chapter is organized to assist the City in making financial decisions. The CIP is based on the evaluation of the City's water distribution system, planning area, and zoning designations.

7.1 CAPITAL IMPROVEMENT PROJECT COSTS

The capacity upgrades set the foundation for the City's water distribution system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, Inc. (Carollo) experience on other projects. The costs are based on an Engineering News Record Construction Cost Index (ENR CCI) 20-City Average of 8,998 (February 2011).

7.2 COST ESTIMATING ACCURACY

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate, deemed appropriate for master plan studies, as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

7.3 CONSTRUCTION UNIT COSTS

The construction costs are representative of water distribution system facilities under normal construction conditions and schedules. Costs have been estimated for public works construction.

7.3.1 Pipeline Unit Costs

Water distribution system pipeline improvements range in size from 8-inches to 12-inches in diameter in this master plan. Pipeline unit costs for relevant sized upgrades are shown in Table 7.1. The unit costs are for "typical" field conditions with construction in stable soil.

Table 7.1 Pipeline Construction Unit Costs Water Distribution System Master Plan City of Cotati	
Pipe Size (inches)	Pipeline Unit Cost (\$/Linear Foot)
8	92
10	115
12	138
Note: 1. ENR CCI 20 City average used for estimating (February 2011) = 8,998	

7.3.2 Storage Tank, Booster Pumps, and Well Costs

Construction unit costs were developed for the storage tanks, booster pumps and groundwater supply wells. The unit costs for these facilities are summarized in Table 7.2. The unit cost for storage tanks are based on completed projects of similar size. The unit cost ranged from a low of \$0.64 per gallon to a high of \$3.37 per gallon, with \$1.35 per gallon representing a typical value. For booster pump stations a unit cost of \$6,700 per horsepower was used. Well construction projects in other cities typically budget about \$500,000 to \$600,000 per 1 mgd. The costs for groundwater supply wells were taken on the lower end of similar projects due to a relatively high water table. Therefore, a unit cost of \$0.5 per gallon was used for estimating well costs.

Table 7.2 Facility Construction Unit Costs Water Distribution System Master Plan City of Cotati	
Facility	Unit Cost
Storage Tanks =	\$1.35 per gallon of storage
Booster Pump Stations =	\$6,700 per horsepower
Groundwater Supply Wells =	\$500,000 per 1 mgd of capacity
Note: 1. ENR CCI 20 City average used for estimating (February 2011) = 8,998	

7.4 PROJECT COSTS AND CONTINGENCIES

7.4.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvements for pipelines, storage tanks, booster pump stations, and wells. Baseline Construction Costs were developed using the following criteria:

- Pipeline: Calculated by multiplying the estimated length by the unit cost.
- Storage Tank: Calculated by multiplying the tank volume by the unit cost.
- Booster Pump Station: Calculated by multiplying the horsepower by the unit cost.
- Groundwater Supply Well: Calculated by multiplying the well capacity in mgd by the unit cost.

7.4.2 Estimated Construction Cost

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. To assist the City in making financial decisions for these future construction projects, contingency costs will be added to the planning budget as percentages of the total construction cost, divided into two categories: Estimated Construction Cost and Capital Improvement Cost.

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 25 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A 25 percent contingency is used to account for unknown site conditions such as poor soils, unforeseen conditions, environmental mitigations, and other unknowns is typical for master planning projects.

7.4.3 Capital Improvement Cost

Other project construction contingency costs are divided into three subcategories, totaling 30 percent: 10 percent engineering, 10 percent construction phase professional services, and 10 percent project administration. Engineering services associated with new facilities include preliminary investigations and reports, ROW acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. For this study, engineering costs are assumed to equal 10 percent of the Estimated Construction Cost.

Construction phase professional services cover such items as construction management, engineering services, materials testing, and inspection during construction. The cost of

these items can also vary, but for the purpose of this study, it is assumed that construction phase professional services expenses will equal approximately 10 percent of the Estimated Construction Cost.

Finally, there are project administration costs, which cover such items as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, and interest during construction. The cost of these items can also vary, but for the purpose of this Master Plan, it is assumed that project administration costs will equal 10 percent of the Estimated Construction Cost.

The Capital Improvement Cost is the total of the Estimated Construction Cost (including contingency) plus the other costs discussed in the previous paragraphs.

As shown in the following sample calculation of the Capital Improvement Cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 62.5 percent of the Baseline Construction Cost. Note that contingencies were not applied to land acquisition costs. Calculation of the 62.5 percent is the overall mark-up on the baseline construction cost to arrive at the capital improvement cost. It is not an additional contingency.

Example:

Baseline Construction Cost	\$1,000,000
<u>Construction Contingency (25%)</u>	<u>250,000</u>
Estimated Construction Cost	1,250,000
Engineering Cost (10%)	125,000
Construction Management (10%)	125,000
<u>Project Administration (10%)</u>	<u>125,000</u>
Capital Improvement Cost	\$1,625,000

A summary of the capital project costs is presented in Table 7.3. This table identifies the projects, provides a brief description of the project, identifies facility size (e.g. pipe diameter and length), and the capital improvement cost. The table also shows the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

7.5 CAPITAL IMPROVEMENT IMPLEMENTATION

The CIP projects are prioritized based on their urgency to mitigate existing deficiencies and for servicing anticipated growth. In addition, each improvement project has been assigned a “project category” as summarized in Chapter 6. It is recommended that improvements to mitigate existing deficiencies be constructed as soon as possible.

Table 7.3 Capital Improvement Plan Water Distribution System Master Plan City of Cotati																		
Figure No.	Type of Improvement	Description/ Street	Description / Limits	Improv. Category	Project Length/Size and Cost					Capital Improvement Phasing					Future Users Benefit ⁽⁶⁾	Reimbursement Category		
					Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost ^{(1),(2)} (\$)	Phase 1 2011-2015 (\$)	Phase 2 2017-2021 (\$)	Phase 3 2022-2026 (\$)	Phase 4 2027-2031 (\$)	Phase 5 2032-2036 (\$)		Existing Improvements (\$)	Future Improvements (\$)	
Existing System Improvements																		
Pipelines																		
P-1	Pipe	Portal Street, Mercantile Drive, Aaron Street	From Portal Street to Houser Street	Category 2	6/8	10	Replace	2,100	\$ 393,000	\$ 393,000					0%	\$ 393,000	\$ -	
P-2	Pipe	West Cotati Avenue	From Gilman Ranch Road to Maple Avenue	Category 2	4	8	Replace	1,700	\$ 255,000	\$ 255,000					0%	\$ 255,000	\$ -	
P-3	Pipe	Nelson Road	Adjacent to the Existing Cypress Tank (Cypress to Water Road)	Category 2	-	10	New	1,900	\$ 356,000	\$ 356,000					0%	\$ 356,000	\$ -	
P-4	Pipe	Water Road	Adjacent to the Existing Cypress Tank (Loma Linda to Benedetti)	Category 2	-	8	Replace	200	\$ 29,000		\$ 29,000				0%	\$ 29,000	\$ -	
P-5	Pipe	Sycamore Lane	West of Cypress Avenue	Category 3	6	8	Replace	600	\$ 89,000		\$ 89,000				0%	\$ 89,000	\$ -	
P-6	Pipe	Amber Lane	East of Woodland Hills Drive	Category 3	6	8	Replace	400	\$ 60,000		\$ 60,000				0%	\$ 60,000	\$ -	
P-7	Pipe	Oak Circle	South of West School Street	Category 3	6	8	Replace	500	\$ 75,000		\$ 75,000				0%	\$ 75,000	\$ -	
P-8	Pipe	Un-named Street off of West School Street	South of West School Street	Category 3	6	8	Replace	700	\$ 106,000		\$ 106,000				0%	\$ 106,000	\$ -	
P-9	Pipe	Un-named Street off of West Cotati Avenue	West of West Cotati Avenue	Category 3	6	8	Replace	500	\$ 75,000		\$ 75,000				0%	\$ 75,000	\$ -	
Storage Tanks and Booster Pumps																		
T-1	Storage Tank	New Cypress Storage Tank	At Existing Cypress Tank Site	Category 1	-	0.4 MG	New	-	\$ 878,000	\$ 878,000					0%	\$ 878,000	\$ -	
T-2	Storage Tank	West Sierra Water Storage Tank 2	Adjacent to Existing West Sierra Tank Site	Category 1	-	1 MG	New	-	\$ 2,194,000		\$2,194,000				53%	\$ 1,031,000	\$ 1,163,000	
BP-1	Booster Pump	Cypress Booster Pumps	Adjacent to New Cypress Tank	Category 1	-	3,000 gpm	New	-	\$ 813,000	\$ 813,000					0%	\$ 813,000	\$ -	
					Existing Improvements Subtotal				\$ 5,323,000	\$2,695,000	\$2,628,000	\$ -	\$ -	\$ -		\$ 4,160,000	\$ 1,163,000	
Future System Improvements																		
Pipelines																		
P-10	Pipe	Blodgett Street, west, Loop back to Helman	Blodgett Street West to Creek, then South parallel to creek	Category 4	-	10	New	1,200	\$ 224,000			\$ 224,000			100%	\$ -	\$ 224,000	
P-11	Pipe	Helman Lane	From P-10 to Existing 12" stub in Helman	Category 4	-	12	New	1,000	\$ 224,000			\$ 224,000			100%	\$ -	\$ 224,000	
P-12	Pipe	Near Ford Lane	Interconnect Helman, Ford and Gravenstein Highway	Category 4	-	10	New	1,100	\$ 206,000				\$ 206,000		100%	\$ -	\$ 206,000	
P-13	Pipe	Near Gilman Ranch Road	From Gilman Ranch Road to Richardson Lane	Category 4	-	10	New	2,000	\$ 375,000				\$ 375,000		100%	\$ -	\$ 375,000	
P-14	Pipe	West School Street	West School Street to West Sierra Avenue	Category 4	-	8	New	1,000	\$ 150,000					\$ 150,000	100%	\$ -	\$ 150,000	
Groundwater Wells																		
W-4	Supply Well ⁽³⁾	Future Well 4	Intersection of Gravenstein Highway and Alder Avenue	Category 1	-	1.25 mgd	New	-	\$ 1,016,000	\$1,016,000					100%	\$ -	\$ 1,016,000	
					Future Improvements Subtotal				\$ 2,195,000	\$1,016,000	\$ -	\$ 448,000	\$ 581,000	\$ 150,000		\$ -	\$ 2,195,000	
					CIP Total (Existing and Future)				\$ 7,518,000	\$3,711,000	\$2,628,000	\$ 448,000	\$ 581,000	\$ 150,000		\$ 4,160,000	\$ 3,358,000	
Notes:																		
1. Baseline Construction Cost plus 25% to account for unforeseen events and unknown conditions.																		
2. Estimated Construction Cost plus 30% to cover other costs including Engineering, Construction Management, and Project Administration.																		
3. Final location of future groundwater wells and storage tanks to be determined.																		
4. Land acquisition costs were included for the storage tank/booster pumps and wells where the City would need to purchase land, but were not included for the pipelines, since these will be located in public right of way.																		
5. Costs are based on the Engineering News Record Construction Cost Index 20-city average of 8998 (February 2011).																		
5. Future user benefit for the West sierra Tank was calculated based on the difference between the existing storage deficiency (0.87 MG) and the volume of the New Cypress Tank (0.40 MG) subtracted from the volume of the new West Sierra Tank (1.0 MG) to account for a 53% future user benefit																		

The implementation phases are separated into 5-year increments. Each project is itemized by phase in Table 7.3 and a summary by improvement category and phase is provided in Table 7.4. Category 1 improvements totaled nearly 5 million of the total 7.32 million due to needed supply and storage upgrades. The remaining categories ranged from 0.41 million to 1.18 million of the total cost. Categories 1-3 should be implemented during the first two phases showing the immediate need and Category 4 should be implemented the remaining phases for future developments. The phasing for the tank and well upgrades was determined by comparing the forecast demand with the available supply and storage capacity.

Table 7.4 Summary of Capital Costs by Improvement Category Water Distribution System Master Plan City of Cotati						
Improvement Category	Implementation Phase					Total (\$, mill.)
	2011-16 (\$, mill.)	2017-21 (\$, mill.)	2022-26 (\$, mill.)	2027 - 31 (\$, mill.)	2032- 36 (\$, mill.)	
Category 1 ⁽¹⁾	2.50	2.19	0.00	0.00	0.00	4.70
Category 2 ⁽²⁾	1.00	0.03	0.00	0.00	0.00	1.03
Category 3 ⁽³⁾	0.00	0.41	0.00	0.00	0.00	0.41
Category 4 ⁽⁵⁾	0.00	0.00	0.45	0.58	0.15	1.18
Total	3.51	2.63	0.45	0.58	0.15	7.32
Notes:						
1. Category 1 projects are supply/storage improvements to meet CDPH standards.						
2. Category 2 projects are mainline improvements to provide needed fire flow.						
3. Category 3 projects are dead end pipeline replacements to provide needed fire flow and to meet AWWA Manual M31 standards.						
4. Category 4 projects provide looping in future development areas.						
5. Costs are based on ENR CCI 20 City average of 8,998 (February 2011).						

7.6 EXISTING VERSUS FUTURE USER COST SHARE

The improvements proposed in this Master Plan either benefit existing users, or are required to service new development and future users. Some of the projects provide benefit to both existing and future users. An opinion of benefit to future users, based on preliminary project information, is included in Table 7.5.

Additionally, costs are broken down for existing and future user cost share of the proposed projects by facility categories (e.g. pipelines, wells, etc.). Existing users will share the cost of 1.44 million of pipeline improvements, 1.91 million for tanks, and 0.8 million for booster pumps. Future users will share the cost associated with 1.18 million worth of pipeline improvements, 0.81 for new wells, 1.16 for supply tanks, and 0.02 for a booster pump station. The cost breakdown for existing and future users is summarized in Table 7.6.

Table 7.5 Existing Versus Future User Cost Share Water Distribution System Master Plan City of Cotati						
Reimbursement Category	Implementation Phase					Total (\$, mill.)
	2011-16 (\$, mill.)	2017-21 (\$, mill.)	2022-26 (\$, mill.)	2027 - 31 (\$, mill.)	2032- 36 (\$, mill.)	
Existing User ⁽²⁾	2.68	1.47	0.00	0.00	0.00	4.14
Future User ⁽³⁾	0.83	1.16	0.45	0.58	0.15	3.17
Total	3.51	2.63	0.45	0.58	0.15	7.32
Notes: 1. Costs are based on ENR CCI 20 City average of 8,998 (February 2011). 2. Projects are funded through user rates. 3. Projects are expected to be funded through water development impact fees collected by the City through new connections.						

Table 7.6 Existing Versus Future User Cost Share by Facility Type Water Distribution System Master Plan City of Cotati					
Reimbursement Category	Facility Type				Total (\$, mill.)
	Pipelines (\$, mill.)	Wells (\$, mill.)	Tanks (\$, mill.)	Booster Pumps (\$, mill.)	
Existing User ⁽²⁾	1.44	0.00	1.91	0.80	4.14
Future User ⁽³⁾	1.18	0.81	1.16	0.02	3.17
Total	2.62	0.81	3.07	0.81	7.32
Notes: 1. Costs are based on ENR CCI 20 City average of 8,998 (February 2011). 2. Projects are funded through user rates. 3. Projects are expected to be funded through water development impact fees collected by the City through new connections.					

**APPENDIX A – 2010 UWMP WATER DEMAND ANALYSIS AND
WATER CONSERVATION MEASURES UPDATE**



City of Cotati



FINAL 2010 Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update

November 16, 2010



**MADDAUS
WATER
MANAGEMENT**

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY	3
1.1 Introduction.....	3
1.2 Long-Term Demand and Conservation Program Analysis Results	3
2. INTRODUCTION AND PURPOSE	6
2.1 Contents	6
3. OVERVIEW OF EVALUATION PROCESS.....	8
4. WATER DEMANDS WITH AND WITHOUT PLUMBING CODE.....	10
4.1 Future Population and Employment Projections	10
4.2 Water Use and Demographic Data Inputs to the Model.....	13
4.3 Key Assumptions for the DSS Model	16
4.4 Water Demand Projections With and Without the Plumbing Code.....	18
4.5 Water Demand Projections – 2005 Urban Water Management Plan (UWMP) Format	21
5. COMPARISON OF INDIVIDUAL CONSERVATION MEASURES.....	22
5.1 Selecting Conservation Measures to be Evaluated (Conservation Measure Screening).....	22
5.2 Perspectives on Benefits and Costs.....	31
5.3 Present Value Parameters	32
5.4 Assumptions about Measure Costs	32
5.5 Assumptions about Measure Savings.....	32
5.6 Assumptions about Avoided Costs	32
5.7 Measure Assumptions including Unit Costs, Water Savings, and Market Penetrations...	33
5.8 Comparison of Individual Measures	33
6. RESULTS OF CONSERVATION PROGRAM EVALUATION.....	35
6.1 Selection of Measures for Programs	35
6.2 Results of Program Evaluation.....	37
7. CONCLUSIONS.....	41
7.1 Relative Savings and Cost-Effectiveness of Programs.....	41

1. EXECUTIVE SUMMARY

1.1 Introduction

The 2010 Urban Water Management Plan demand and conservation technical analysis was conducted by Maddaus Water Management (MWM) for the City of Cotati. The purpose of the analysis was to:

1. Calculate a demand forecast for the year 2010 to 2035.
2. Calculate the range of conservation costs and savings for the year 2010 to 2035. This effort included:
 - Incorporate activity from current conservation measures for the year 2005 and 2009 into the DSS model.
 - Evaluate up to three new conservation measures that will reduce future water demand.
 - Estimate the costs and water savings of these measures.
 - Combine the measures into increasingly more aggressive programs and evaluate the costs and water savings of these programs.

1.2 Long-Term Demand and Conservation Program Analysis Results

The project for the Sonoma County Water Agency (SCWA) contractors included two main parts, (1) create a demand and conservation analysis for 2010 to 2035 and (2) evaluate conservation savings potential for the years 2010 to 2035 with a variety of different measures and conservation programs.

The first step in the analysis was to review and analyze historical water use production and billing data. For most contractors, the billing data was provided for the years 2000 to 2009 (a few contractors had data back to 1995 and one contractor has new meters, so data is only available after the year 2006). The data was graphically analyzed and discussed with the individual contractors. The historical water use along with the selected population and employment projections were used to create a demand forecast for the year 2010 to 2035.

Once the demands were completed, the conservation measures were analyzed for a total of 31 measures. The conservation analysis included all the measures from the 2005 conservation study that MWM completed for the SCWA contractors along with up to three new measures for each contractor. The following important assumptions about the conservation measures were included in this analysis:

1. Due to increased regulations and additional research and analysis on conservation measures, conservation measures Tier 2-8 (Reduced Connection Fees), Tier 2-9 (Synthetic Turf Rebate) and Tier 2-11 (Dishwasher Rebate) were removed from all programs at the request of the contractors.
2. No modifications to costs or savings assumptions were made to any of the Tier One and Tier Two Measures. To comply with new regulations and ordinances, minimal changes were made to the New Development measures ND-1 to ND-8
3. The table of the new measures for each contractor is listed in Section 5.1. An analysis of the new state law SB 407 was included for all contractors.
4. New development ordinances were updated to reflect new local ordinances, the Model Water Efficient Landscape Ordinance, and the Cal Green building code.

Table ES-1, ES-2 and ES-3 and Figure ES-1 show the water demands and conservation savings for the years 2010 to 2035. The Plumbing Code includes the new California State Law requiring High Efficiency Toilets and High Efficiency Urinals by 2014.

**Table ES-1
Conservation Measures**

City of Cotati Conservation Measures in each Program						
Measure Name	Program Existing	Program Existing & New	Program Tier One	Program Tier One & Tier Two	Program Tier One & ND	Program Tier One & ND & Tier Two
CUWCC #1a - Residential Water Surveys - Interior	✓	✓	✓	✓	✓	✓
CUWCC #1b - Residential Water Surveys - Outdoor	✓	✓	✓	✓	✓	✓
CUWCC #5a - Large Landscape Water Budgets	✓	✓	✓	✓	✓	✓
CUWCC #6 - Washer Rebates	✓	✓	✓	✓	✓	✓
CUWCC #7 - Residential Public Education	✓	✓	✓	✓	✓	✓
CUWCC #9 - Commercial Water Audits	✓	✓	✓	✓	✓	✓
CUWCC #14a - RSF Toilet Replacement	✓	✓	✓	✓	✓	✓
CUWCC #14b - RMF Toilet Replacement	✓	✓	✓	✓	✓	✓
Tier 2 - 1 Rain Sensor Retrofit				✓		✓
Tier 2 - 2 Cash for Grass				✓		✓
Tier 2 - 3 Financial Incentives for Being Below Water Budget				✓		✓
Tier 2 - 5a Smart Irrigation Controller Rebates - RSF				✓		✓
Tier 2 - 5b Smart Irrigation Controller Rebates - RMF, CII, IRR				✓		✓
Tier 2 - 6 Financial Incentives/Rebates for Irrigation Upgrades				✓		✓
Tier 2 - 10 High Efficiency Toilets				✓		✓
Tier 2 - 12 CII Rebates - Replace Inefficient Water Using Equipment				✓		✓
Tier 2 -13 New Commercial Urinals				✓		✓
Tier 2 - ND1 Rain Sensor Retrofit					✓	✓
Tier 2 - ND2 Smart Irrigation Controller	✓	✓			✓	✓
Tier 2 - ND3 High Efficiency Toilets	✓	✓			✓	✓
Tier 2 - ND4 Dishwasher New Efficient	✓	✓			✓	✓
Tier 2 - ND5 Clothes Washing Machine Requirement	✓	✓			✓	✓
Tier 2 - ND6 Hot Water on Demand					✓	✓
Tier 2 - ND7 High Efficiency Faucets and Showerheads	✓	✓			✓	✓
Tier 2 - ND8 Landscape and Irrigation Requirements	✓	✓			✓	✓
SB 407 Requirements (Plumbing Retrofit on Resale or Remodel)		✓				
Tiered Water Rates		✓				

NOTE – Due to increased regulations and additional research and analysis, conservation measures Tier 2-8, Tier 2-9 and Tier 2-11 are out of date and were removed from analysis at the request of all the contractors.

For additional information on Table ES-1, ES-2 and ES-3 see Section 6.1 and Section 6.2.

Figure ES-1
Long Term Demands with Conservation Programs

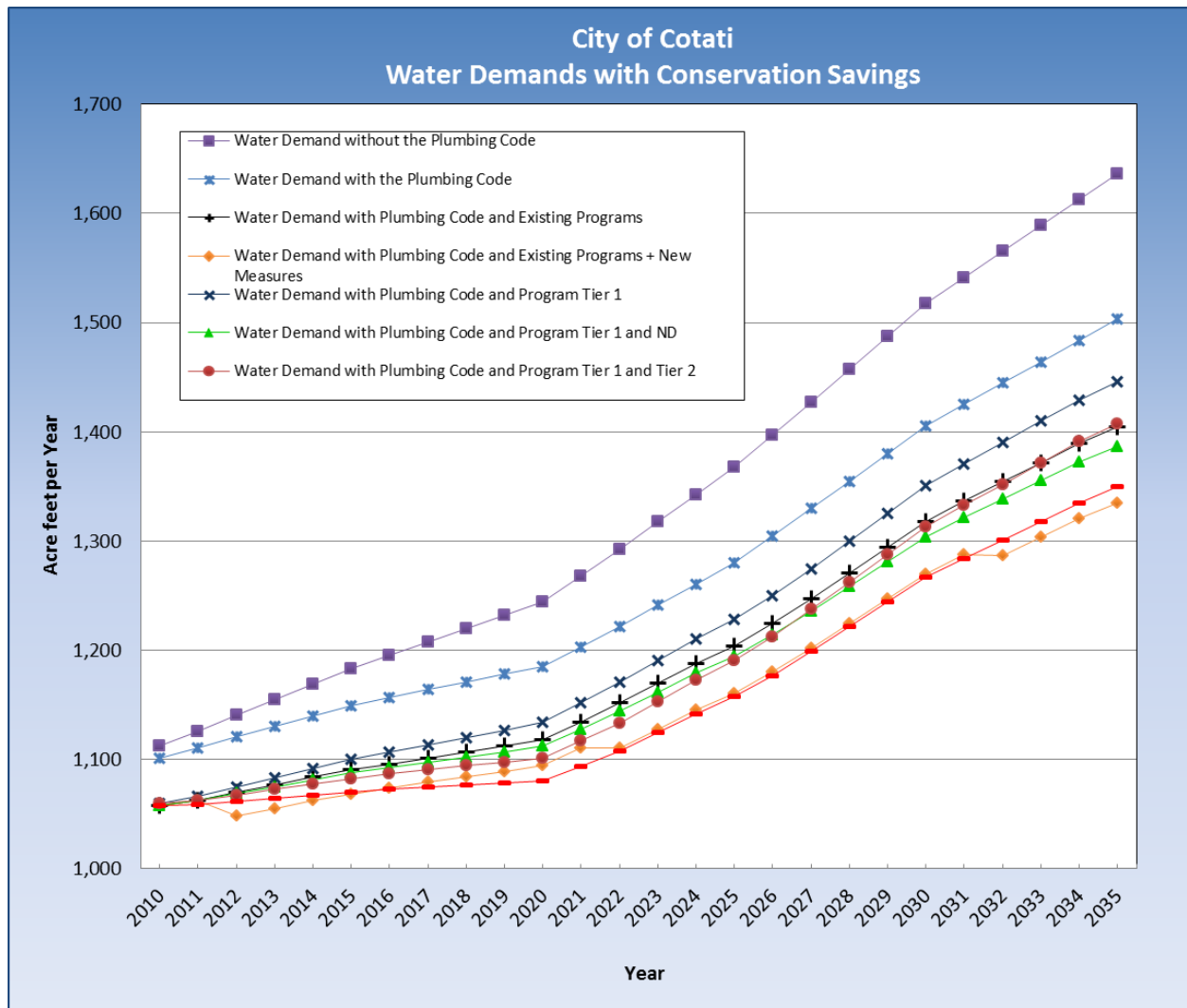


Table ES-2
Water Demand Projections

City of Cotati Water Demand with Conservation Program Savings						
Water Demand with Plumbing Code and Conservation Program Savings (AFY)	2010	2015	2020	2025	2030	2035
Water Demand without the Plumbing Code	1,113	1,183	1,244	1,367	1,517	1,636
Water Demand with the Plumbing Code	1,101	1,150	1,185	1,281	1,405	1,503
Water Demand with Plumbing Code and Existing Programs	1,058	1,091	1,118	1,204	1,318	1,405
Water Demand with Plumbing Code and Existing Programs + New Measures	1,058	1,069	1,095	1,161	1,270	1,335
Water Demand with Plumbing Code and Program Tier 1	1,060	1,100	1,134	1,228	1,351	1,446
Water Demand with Plumbing Code and Program Tier 1 and ND	1,058	1,088	1,112	1,195	1,304	1,387
Water Demand with Plumbing Code and Program Tier 1 and Tier 2	1,060	1,083	1,102	1,191	1,313	1,408
Water Demand with Plumbing Code and Program Tier 1 and ND and Tier 2	1,058	1,071	1,081	1,158	1,267	1,350

Table ES-3
Economic Analysis of Alternative Programs

City of Cotati Comparison of Conservation Program Costs and Savings									
Conservation Program	Water Utility Benefit-Cost Ratio	Community Benefit-Cost Ratio	2035 Water Savings (AFY)	2035 Indoor Water Savings (AFY)	2035 Outdoor Water Savings (AFY)	Total Water Savings as a % of Total Production in 2035	30 Year Present Value of Water Utility Costs (\$1,000)	Total Utility Cost Five Years 2011-2015 (\$1,000)	Utility Cost of Water Saved (\$/AF)
Existing Program	2.27	0.74	99	42	56	6.57%	\$456	\$92	\$223
Existing Program + New Measures	2.56	0.91	169	59	110	11.23%	\$570	\$137	\$190
Tier One	1.88	2.22	58	21	37	3.85%	\$425	\$82	\$281
Tier One + Tier Two	1.25	0.74	96	23	73	6.38%	\$916	\$388	\$406
Tier One + New Development	2.42	0.64	116	54	63	7.75%	\$466	\$94	\$206
Tier One + Tier Two + New Development	1.54	0.51	154	55	99	10.24%	\$957	\$401	\$319

2. INTRODUCTION AND PURPOSE

The purpose of this report is to present an overview of the demand and conservation evaluation process which has been completed for the City of Cotati (City). The goal was to develop forecasts of demand and conservation savings for the 2010 Urban Water Management Plan.

The City of Cotati has a current water conservation program. This report evaluates whether expanding existing efforts is a cost-effective way to meet future water needs.

The conservation measures and programs were analyzed using the Least Cost Planning Water Demand Management Decision Support System (DSS Model). In this report demand management and water conservation are used interchangeably. The evaluation includes measures directed at existing accounts as well as new development measures to make new residential and business customers more water efficient. Six programs were provided to help evaluate the net effect of running multiple measures together over time. Assumptions and results for each of the 31 individual measures and six programs will be described in detail in this report.

2.1 Contents

This report provides a general overview for the methodology, assumptions, and results for the demand forecast and conservation analysis. The following information is included in this report and is discussed in individual sections below:

- Overview of evaluation process
- Baseline water demands with and without the plumbing code
- Comparison of individual conservation measures
- Results of the conservation analysis
- Conclusions
- Appendix A: Assumptions for the Conservation Measures Evaluated

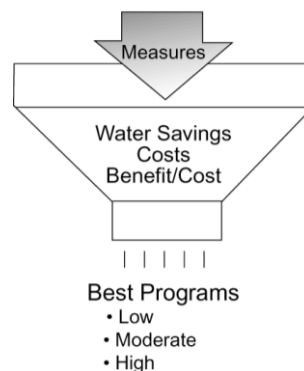
- Appendix B: Water Production and Billing Data Graphs for all Customer Categories

3. OVERVIEW OF EVALUATION PROCESS

Long Term Demand and Conservation Evaluation Process

During the evaluation process, water demand and savings were estimated. Benefits and costs were compared in a formal present value analysis and conclusions were drawn about which measures produce cost-effective water savings. The measure costs were previously developed by MWM and the contractors as part of the 2005 conservation study MWM completed for the SCWA contractors. This process can be thought of as an economic screening process, shown in Figure 1. Packaging the best measures into alternative programs allows the City of Cotati to consider what level of conservation implementation is appropriate.

Figure 1
Evaluation Process



Benefit-cost analysis has been used by many water agencies to evaluate and help select a water conservation measure best suited to local conditions. This analysis requires a locale-specific set of data, such as historical water consumption patterns by customer class, population projections, age of housing stock, and prior conservation efforts.

The following ten steps were used to implement the methodology by expanding upon the same DSS Model used to prepare the demand projections.

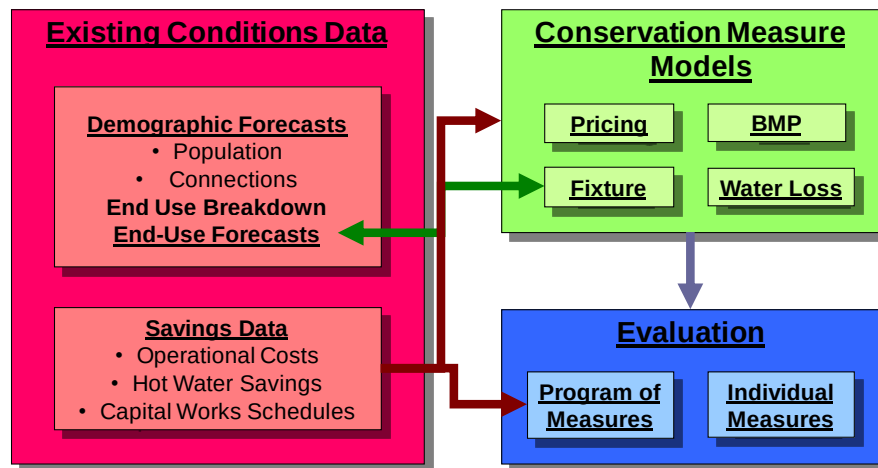
1. **Generate water use projections with and without the state and national plumbing code.** Projections cover each key customer category and are broken down into indoor and outdoor end uses. Evaluate the impact of the plumbing code changes arising from the 1992 and 2005 Federal Energy Policy Act. The plumbing code also includes fixture changes that will result from the State of California plumbing code which requires only high efficiency toilets and high efficiency urinals be sold in the state after the year 2014.
2. **Evaluate previous conservation measures and up to three new measures** to identify those that are applicable to the service area. Develop appropriate unit water savings and costs for each measure.
3. **Estimate the affected customers (or number of accounts) for each conservation measure** by dividing the measure's projected customers (or accounts) that implement the measure by the total service area customers (accounts). This factor is called the market penetration or installation rate.
4. **Estimate total annual average day water savings.** The water savings are computed by multiplying unit water savings, per measure, by the market saturation or installation rate (i.e.

10% to 90% of accounts), and then multiplying by the number of units in the service area (such as dwelling units) targeted by a particular measure. The indoor and outdoor water savings were also calculated.

5. **Identify benefits to the water agency** including potential reduced water purchases from SCWA, calculated as the wholesale water rate and delivery cost per acre-foot for each contractor with an escalator based on historical water rates and Consumer Price Index (CPI).
6. **Quantify total benefits for each year** in the planning period by multiplying average water savings for each measure by the computed value of the benefits.
7. **Determine initial and annual costs to implement the measures** based upon current conservation program data, local experience, and the costs of goods, services, and labor in the community. This is multiplied by the number of units participating each year and then added to overall administration and promotion costs to arrive at a total measure cost, which may be spread over a number of years. For this project the costs for all measures were used from the 2005 study, except for the three new measures selected by each contractor which had all new parameters developed.
8. **Compare costs of measures** by computing the present value of costs and costs of water saved over the planning period.
9. **Compile six programmatic packages** or programs containing various new and existing measures.
10. **Evaluate the six programs for water savings and cost-effectiveness** and identify the point of diminishing returns from further investments in conservation.

For conservation measure evaluation, the DSS Model performs economic analysis by using net present value and benefit-to-cost ratio as economic indicators. The benefit cost analysis is performed from various perspectives including the utility and community (community perspective equates to the utility plus customer). Figure 2 shows the structure of the model. Results are presented in subsequent sections.

Figure 2
Structure of the DSS Model



4. WATER DEMANDS WITH AND WITHOUT PLUMBING CODE

4.1 Future Population and Employment Projections

Description of Population and Employment Forecasts

There are generally three main sources of population and employment projections used to generate future water demands for the 2010 Urban Water Management Plans.

Available Demographic Projections

- *Local General Plan (population and employment)* – Typically these plans, depending upon when they were published, have a population and jobs forecast for 2030 and build out.
- *Association of Bay Area Governments (ABAG) (population and employment)* - ABAG recently published a new projections report in 2009 that includes population and employment estimates for each city in the Bay Area. This report provides estimates for 2000, 2005, 2010, 2015, 2020, 2025, 2030 and 2035. ABAG publishes demand projections every two years. The previous DSS Model projections, the ABAG Projections for 2005 2007, and 2009 were reviewed to determine the most appropriate data set to use in this DSS Model update. *Other Water Supply Planning Reports*

At the City of Cotati's request, the population projections were based on the 2007 City of Cotati Water Supply Assessment (WSA) and the employment projections were based on 2009 ABAG jurisdictional data as shown in Figure 3, 4 and Table 1 and 2. The values shown in the "Selected" column were used to create the demand projections. The current General Plan anticipates in-fill development constituting the vast majority of the development in this planning horizon. Development served by the City of Cotati utilities outside the current jurisdictional boundaries is expected to be minor. The 2007 WSA population projections were based on historical trends on new units created each year.

Figure 3
Population Projections

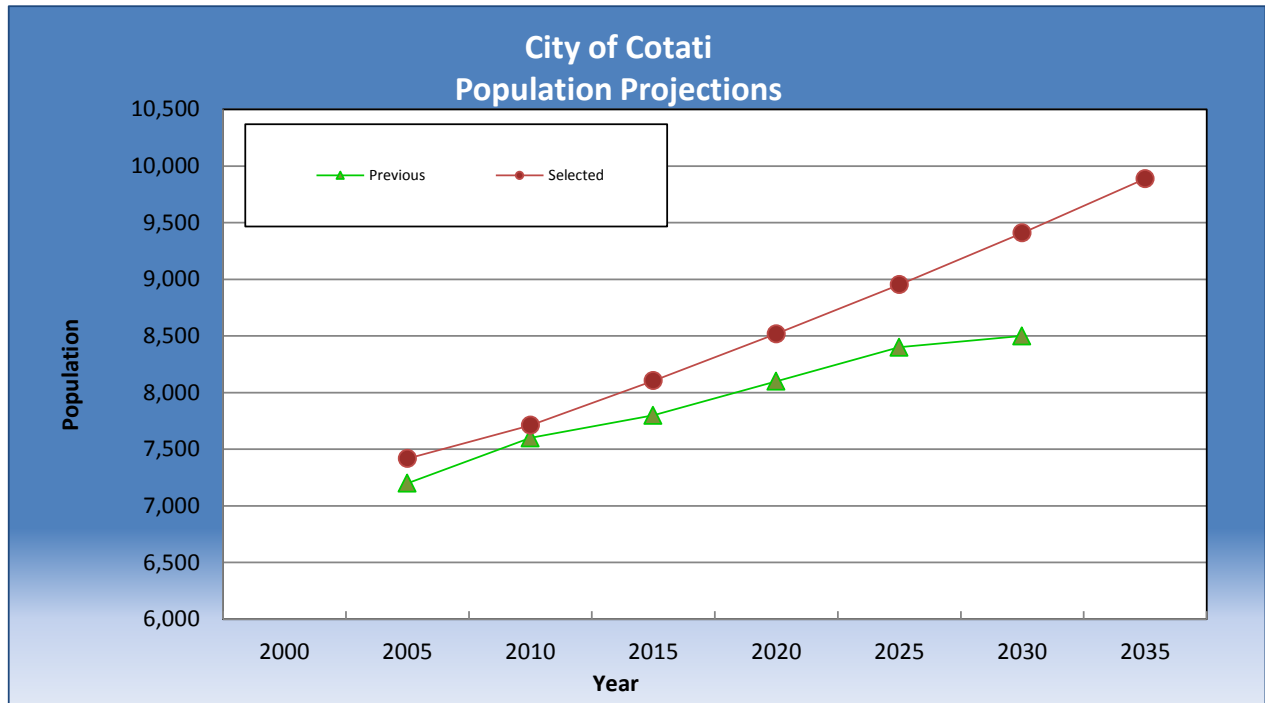


Table 1
Table of Population Projections

City of Cotati Population Projections		
Year	Previous ¹	Selected ^{2,3}
2000		
2005	7,200	7,418
2010	7,600	7,711
2015	7,800	8,105
2020	8,100	8,518
2025	8,400	8,953
2030	8,500	9,409
2035		9,889

Notes:

- 1) DSS Model data based on the 2005 ABAG jurisdictional data
- 2) Based on the Cotati Water Supply Assessment page 3-3 table 3-1
- 3) In 2007, Population was 7535 according to Cotati Water Supply Assessment page 3-3 table 3-1

Figure 4
Employment Projections

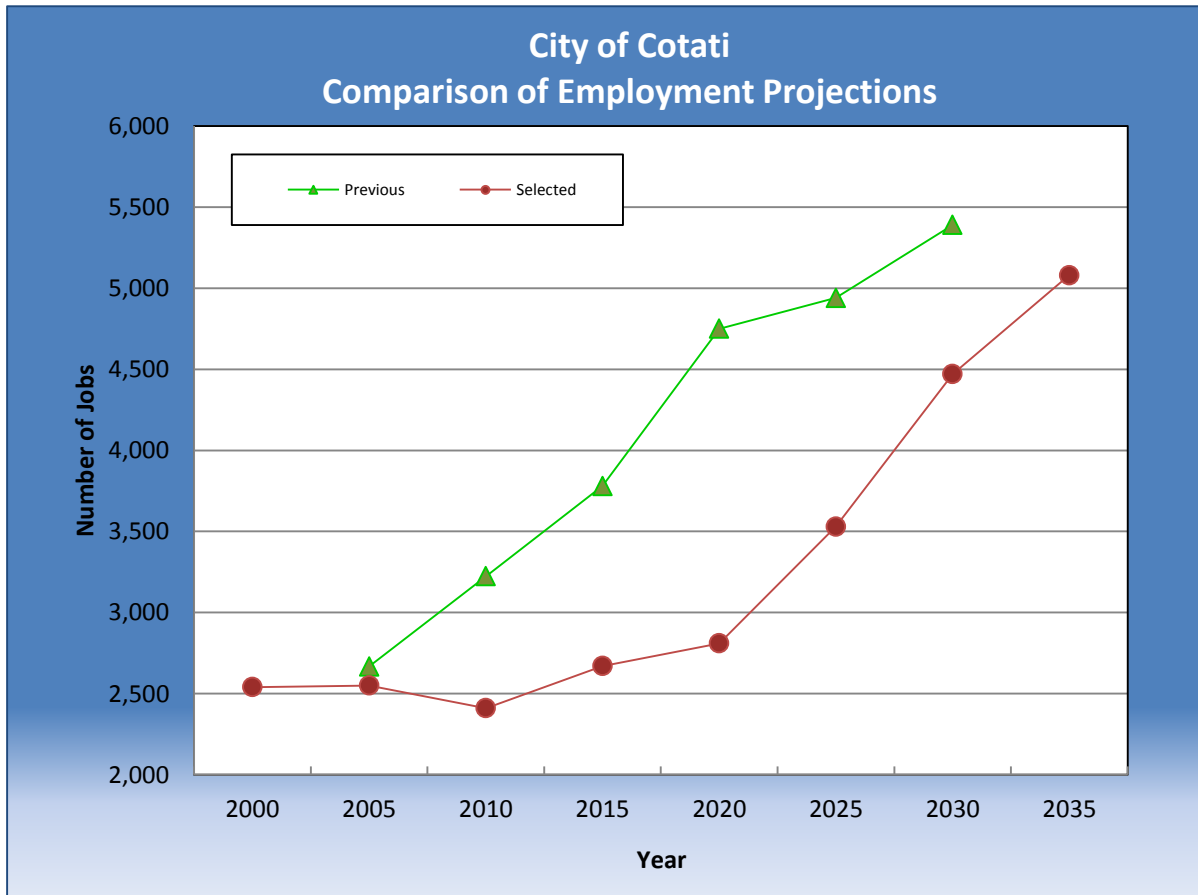


Table 2
Table of Employment Projections

City of Cotati Employment Projections		
Year	Previous ¹	Selected ²
2000		2,540
2005	2,667	2,550
2010	3,224	2,410
2015	3,780	2,670
2020	4,750	2,810
2025	4,940	3,530
2030	5,390	4,470
2035		5,080

Notes:

1) DSS Model data based on the 2005 ABAG jurisdictional data

2) Based on ABAG 2009 Jurisdictional data

4.2 Water Use and Demographic Data Inputs to the Model

Description of “Water Use Data Input Sheet”

Figure 5 is a two-page print out of an Excel spreadsheet. The purpose of this “Water Use Data Input Sheet” is to gather and document basic information about the individual service area. The data shown on the “Water Use Data Input Sheet” can be broken into two main categories, (a) current water use data and (b) demographic data. Each area is broken out below and helps to provide some basic definitions and assumptions.

(a) Water Use Data

- *Model Start Year* – This is the starting year for the analysis. For this project, the start year for the model is 2005. The selection of 2005 as a model start year allowed the historical conservation efforts to be included for the past 5 years (2005 to 2009). The DSS Model includes 30 years of data projecting information until the year 2035.
- *Base Year for Future Water Factors* – Based on an analysis of historical water billing data, each contractor selected a year or average of multiple years that is representative of current water use and used as a base year demand factor for developing future water use projections. The year(s) was chosen by the contractors for the following reasons:
 1. The selected years shows less of an effect of the recession. For all contractors the years 2008 and 2009 show a dip in water demand in many areas due to reduction in economic activity.
 2. The years selected had relatively “normal” climate conditions – i.e. not a drought or excessively wet year, so no significant weather adjustments were necessary. For all contractors the years 2008 and 2009 were affected by drought conditions. The water billing or production data was not weather normalized for this analysis.
 3. Many contractors elected to average a few years of data for the analysis. Some contractors selected an individual year as they felt it was representative in terms of weather, vacancy, and customer water use for demand projection purposes.
 4. No additional adjustment factors were added other than the “new single family home category” for three of the contractors (City of Santa Rosa, Valley of the Moon and North Marin Water District). The adjustment was made based on analysis of actual data which showed an increase in water use for homes built since 2000.
- *Average gal/day/acct-* This is the amount of water in gallons that is used per day, per account.
- *Indoor/outdoor water use* – This is the amount of water per account split into the percent that is used indoors and outdoors.
- *Consumption by customer class-* This shows the annual amount of water used for an entire calendar year, broken down by customer class (Single Family, Multi Family, Commercial, Irrigation, etc)
- *Provision for New Single Family Account Use*– For selected agencies, and upon their specific request, a new category was created to model water use of new single family homes. This value is held constant in the baseline projection and not subject to plumbing codes. All new homes include the plumbing code change in the State of California that requires HETs in 2014. The new homes will also be affected by Cal Green building code after July 1, 2011 and required to install efficient fixtures for the toilets, low flow shower heads and faucets. The effects from Cal Green were run as a conservation measure as they were not in effect at the time of this analysis.
- *Unaccounted for water (UFW) also known as Non Revenue Water* – This is the sum of all water input to system that is not billed (metered and unmetered) water consumption, including

apparent (metering accuracy) and real losses. The values were calculated by taking the difference between the amount of water produced and the amount of water that was sold. Data provided by the water contractor was used, if provided, unless UFW was less than 7 percent, in which case 7 percent was used.

- *Water Produced*– This is the total amount of potable water produced. The water can come from multiple sources including amount purchased from SCWA, purchased from other agencies, local surface water, or obtained from groundwater. This does not include recycled water.
- *Peak day factor* – The ratio of water produced on the maximum day of the year to that produced on the average day.

(b) Demographic Data

- *Census 2000* – The 2000 Census data was used as a general reference when determining population and household sizes for each individual city (and/or unincorporated area) serviced by the water agencies.
- *2005 City of Cotati Service Area Population*- The 2005 total population for the City of Cotati was taken directly from the 2005 selected population source discussed earlier in this report.
- The future population projections were set to be a Single family / multi family split of 50% / 50% as requested by the City of Cotati. The current 2005 population is currently 77.5% Single family and 22.5% multi family. The split was modified to reflect General Plan emphasis on multi family for new development.
- *Single and multi family dwelling units*- The 2005 single family dwelling units is equal to the number of single family accounts for 2005. The 2005 multi family dwelling unit estimate was calculated by applying a growth factor to the 2000 data as noted on the water use data sheet in Figure 5.
- *Procedure for service areas not contiguous with city boundaries* – When a service area serves outside a city boundary, estimates were generated either from census tract data when available for the unincorporated areas, Department of Finance data, ABAG Projections, DWR reported data, General Plan or by the local water district if known. If none of the six sources were available, then the modeling team worked with the local water district to make reasonable estimates.
- *Employment data*– The employment figures were obtained from the selected source as discussed earlier in this report.

In summary, the key features of this sheet include the existing 2005 level of water use, 2005 baseline accounts in each customer category, and 2005 baseline forecasts for population and employment.

Figure 5
Water Use Data Input Sheet

City of Cotati Water Service Area ¹								
DSS Input Sheet								
November 12, 2010								
Water Demand Factors Average Use and Indoor Percentages by Billing Category for DSS Model ²								
	Single family		Multifamily		Commercial		Irrigation	
Year	Average, gpd/a	Indoor	Average, gpd/a	Indoor	Average, gpd/a	Indoor	Average, gpd/a	Indoor
2006,2007	244.2	63%	1187.9	76%	708.8	74%	791.6	0%
Commercial Irrigation								
			City and Irrigation		Apt Irrigation			
			Average, gpd/a	Indoor	Average, gpd/a	Indoor		
			723.5	0%	890	0%		
City Buildings and Parks								
Data for DSS Model -- Start Year: 2005								
Category	Number of Accounts in Start Year ³	Water Use in Base Year gpd/a ²	Water Use, MGD	Use Profile Percent	Water Use gcd	Indoor Water Use gcd		
Single family	2,035	244.2	0.497	57.08%	86.4	54.3		
Multifamily	97	1,187.9	0.115	13.24%	69.9	53.4		
Commercial	161	708.8	0.114	13.11%				
Irrigation	127	791.6	0.101	11.55%				
City and Irrigation	42	724	0.030	3.49%				
Apt Irrigation	15	890	0.013	1.53%				
Total Billed	2,420	4,546	0.871	100.00%				
Total Water Produced Non-Weather Normalized ⁴ =			0.994	MGD				
Start Year Unaccounted For Water (UFW) ⁵ =			12.4%	Percent				
Projected UFW for DSS Model =			10.9%	Percent	7% if actual is < 7%, otherwise = agreed upon by agency for 30 year forecast			
Water Produced for use in DSS Model for 2005			0.977	MGD	Add UFW % to Total Billed Water Use			
					Water Produced	Billed / (1- Projected UFW for DSS	0.977	
Peaking Factor			NA	Provided by Agency or Water Master Plan (or NA)				
Peaking Factor for DSS Model=			2.4	Provided by Agency				
- Blue cells are entered by modeler - Yellow cells are input to DSS Model								
NOTES								
1. - Communities served (includes all or portions of) Cotati and surrounding rural areas								
2 - Average gpd/a is based on a 12-month moving average through December 2009. Indoor use is based on average of 2 lowest consecutive months in the winter if meters read bimonthly, or single lowest month if meters read monthly.								
3 - Number of accounts is from data provided by water agency for this project (see worksheet with account data in this file)								
4 - Total water produced for 2005 was provided by City of Cotati								
5 - Unaccounted for Water (UFW) is the percent difference between the total water purchased and the total billed water use. If the UFW was less than 7%, then 7% was used for planning purposes.								
6 - For reference see additional population estimates provided in population and employment estimates corresponding to service area table.								
7 - Initial estimate based on census data for renter occupied units. For reference see table below that has 2000 census data for corresponding water service area, city or cities.								
8 - Group Quarters Population includes Institutionalized and non-Institutionalized and assumes their water use is in the								
Definitions / Abbreviations								
ABAG	Association of Bay Area Governments			HHS	household size			
DOF	Department of Finance			NA	not available			
DSS	Decision Support System Model			MF	multi family			
du	dwelling unit			MGD	million gallons per day			
FY	Fiscal Year			No.	number			
gcd	gallons per capita / per day			Pop	population			
gpd/a	gallons per day / per account			Res	residential			
gpd	gallons per day			SF	single family			
				UFW	unaccounted for water			
Data Prepared:	May 1, 2005	By: M. Maddaus						
Revised:	November 12, 2010	By: C. Matyas						

[illegible]

4.3 Key Assumptions for the DSS Model

City of Cotati

Table 3
List of Baseline Demand Projection Assumptions for DSS Model

City of Cotati List of Baseline Demand Projection Assumptions for DSS Model	
Parameter	Model Input Value, Assumptions, and Key References
Model Start Year	2005
Water Demand Factor Year(s)	Average of Years: 2006,2007
Peak Day Factor	2.4
Unaccounted for Water in the Start Year	10.9% based on Average of Years 2005-2007 data
Population Projection Source	Cotati Water Supply Assessment page 3-3 table 3-1
Employment Projection Source	ABAG 2009 Jurisdictional data
Number of Water Accounts for Start Year	2477
Avoided Cost of Water \$/AF (includes escalated SCWA cost + \$27.7 / AF for pumping cost)	\$827.11
Distribution of Water Use Among Categories	Single Family: 57.1% Multifamily: 13.2% Commercial: 13.1% Apt Irrigation: 1.5% Irrigation: 11.5% City and Irrigation: 3.5%
Indoor Water Use by Category	Single Family: 62.8% Multifamily: 76.4% Commercial: 73.8% Apt Irrigation: 0% Irrigation: 0% City and Irrigation: 0%
Residential End Uses	AWWARF Report "Residential End Uses of Water" 1999
Non-Residential End Uses, %	AWWARF Report Commercial End Uses of Water" 1999
Efficient Residential Fixture Current Installation Rates	U.S. Census, Housing age by type of dwelling plus natural replacement plus rebate program (if any). Reference "High Efficiency Plumbing Fixtures - Toilets and Urinals" Koeller & Company July 23, 2005. Reference Consortium for Efficient Energy (www.cee1.org)
Water Savings for Fixtures, gal/capita/day	AWWARF Report "Residential End Uses of Water" 1999, , CUWCC Cost and Savings Study April 28, 2005, Agency supplied data on costs and savings, professional judgement where no published data available
Non-Residential Fixture Efficiency Current Installation Rates	U.S. Census, assume commercial establishments built at same rate as housing, plus natural replacement
Residential Frequency of Use Data, Toilets, Showers, Washers, Uses/user/day	Falls within ranges in AWWARF Report "Residential End Uses of Water" 1999
Non-Residential Frequency of Use Data, Toilets and Urinals, Uses/user/day	Estimated based using AWWARF Report "Commercial and Institutional End Uses of Water" 1999
Natural Replacement Rate of Fixtures	Residential Toilets 3% (1.28 gpf toilets), 4% (1.6 gpf and higher toilets) Commercial Toilets 3% (1.28 gpf toilets), 4% (1.6 gpf and higher toilets) Residential Showers 4% Residential Clothes washers 6.7% A 3% replacement rate corresponds to 33 year life of a new fixture. A 6.67% replacement rate corresponds to 15 year washer life based on "Bern Clothes Washer Study, Final Report, Energy Division, Oak Ridge National Laboratory, for U.S. Department of Energy, March 1998, Internet address: www.energystar.gov
Future Residential Water Use	Increases Based on Population Growth
Future Non-Residential Water Use	Increases Based on Employment Growth

4.4 Water Demand Projections With and Without the Plumbing Code

Development of the Water Demand Projections Table and Graph

Water demand projections were developed to the year 2035 using the Demand Side Management Least Cost Planning Decision Support System (DSS) model. This model incorporates information from the:

- “Water Use Data Sheet” and the “Key Assumptions”
- Questions asked of agencies
- Contractor provided data
- 2000 Census data and 2006-08 American Community Survey 3 year estimates
- Local General Plans
- Association of Bay Area Governments Projections

Water demand projections were input for 30 years using the DSS Model. This model incorporates information from the:

- Contractor selected population and employment forecasts.
- Data provided by City of Cotati staff including historical water use, past conservation efforts, and water system facilities.

Table 4 shows the projected demands with and without plumbing codes and appliance standards. This page includes both a table and a graph. Each will be described below.

National Plumbing Code

The Federal Energy Policy Act of 1992, as amended in 2005 requires only fixtures meeting the following standards can be installed in new buildings:

- Toilet – 1.6 gal/flush maximum
- Urinals – 1.0 gal/flush maximum
- Showerhead - 2.5 gal/min at 80 psi
- Residential Faucets – 2.2 gal/min at 60 psi
- Public Restroom Faucets - 0.5 gal/min at 60 psi
- Dishwashing pre-rinse spray valves – 1.6 gal/min at 60 psi

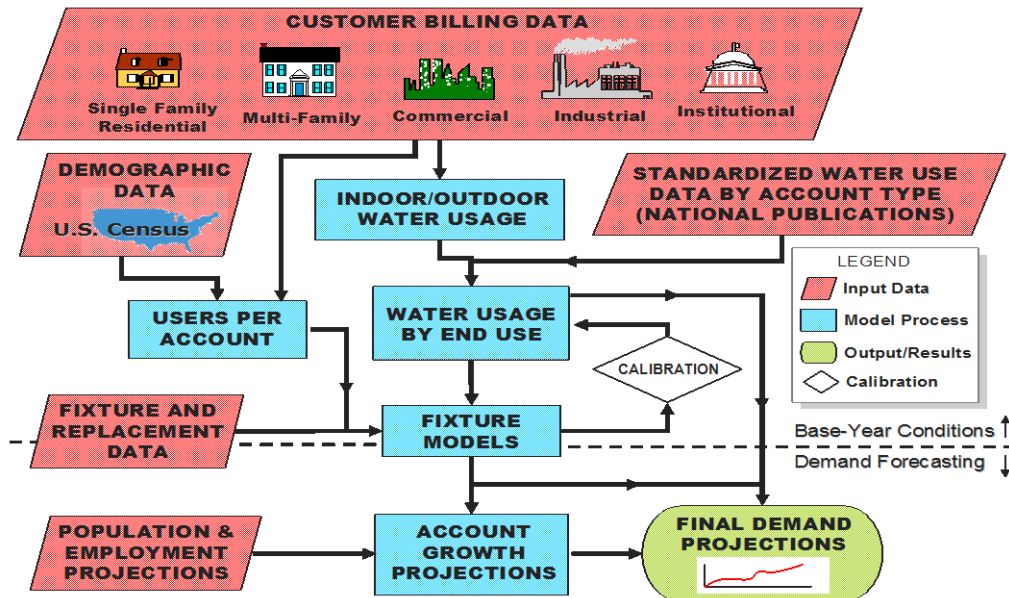
Replacement of fixtures in existing buildings is also governed by the Federal Energy Policy Act that requires only devices with the specified level of efficiency (shown above) can be sold today (2010). The net result of the plumbing code is that new buildings will have more efficient fixtures and old inefficient fixtures will slowly be replaced with new more efficient models. The national plumbing code is an important piece of legislation and must be carefully taken into consideration when analyzing the overall water efficiency of a service area.

In addition to the plumbing code the US Department of Energy regulates appliances such as residential clothes washers. Regulations to make these appliances more energy efficient has driven manufacturers to dramatically reduce the amount of water these efficient machines use. Generally horizontal axis washing machines use 30-50 percent less water than conventional models (which are still available). In the analysis for City of Cotati, the DSS Model forecasts a gradual transition to high efficiency clothes washers (using 19 gallons or less) so that by the year 2020 this will be the only type of machines purchased. In addition to the industry becoming more efficient, rebate programs for washers have been successful in encouraging customers to buy more water efficient models. Given that machines last about 15 years eventually all machines in the City of Cotati area will be of this type.

State Plumbing Code

The Plumbing Code includes the new California State Law requiring High Efficiency Toilets and High Efficiency Urinals be exclusively sold in the state by 2014. Figure 6 below describes conceptually how the above listed items are incorporated into the flow of information in the DSS Model.

Figure 6
DSS Model Overview Used to Make Potable Water Demand Projection
“With the Plumbing Code”



Graph of projected demands (Figure 7)

Figure 7 shows the potable water demand projection at five-year increments. The graph shows projections for demand with and without the plumbing code through 2035.

Table of water demand projections (Table 4)

The table of water demands projections includes:

1. The water demand projections shown in Table 4 are based on the future population and employment projections provided in Table 1 and Table 2.
2. Projections were made *with and without* the plumbing codes.
3. Projections are for potable water only. It does not include recycled water use. Recycled water use and projections are included in a separate Chapter of the UWMP.

Dry Year Demands

The demand projections reflect average weather conditions and **do not** reflect drier and hotter drought conditions.

Figure 7

Potable Water Use Projections for City of Cotati

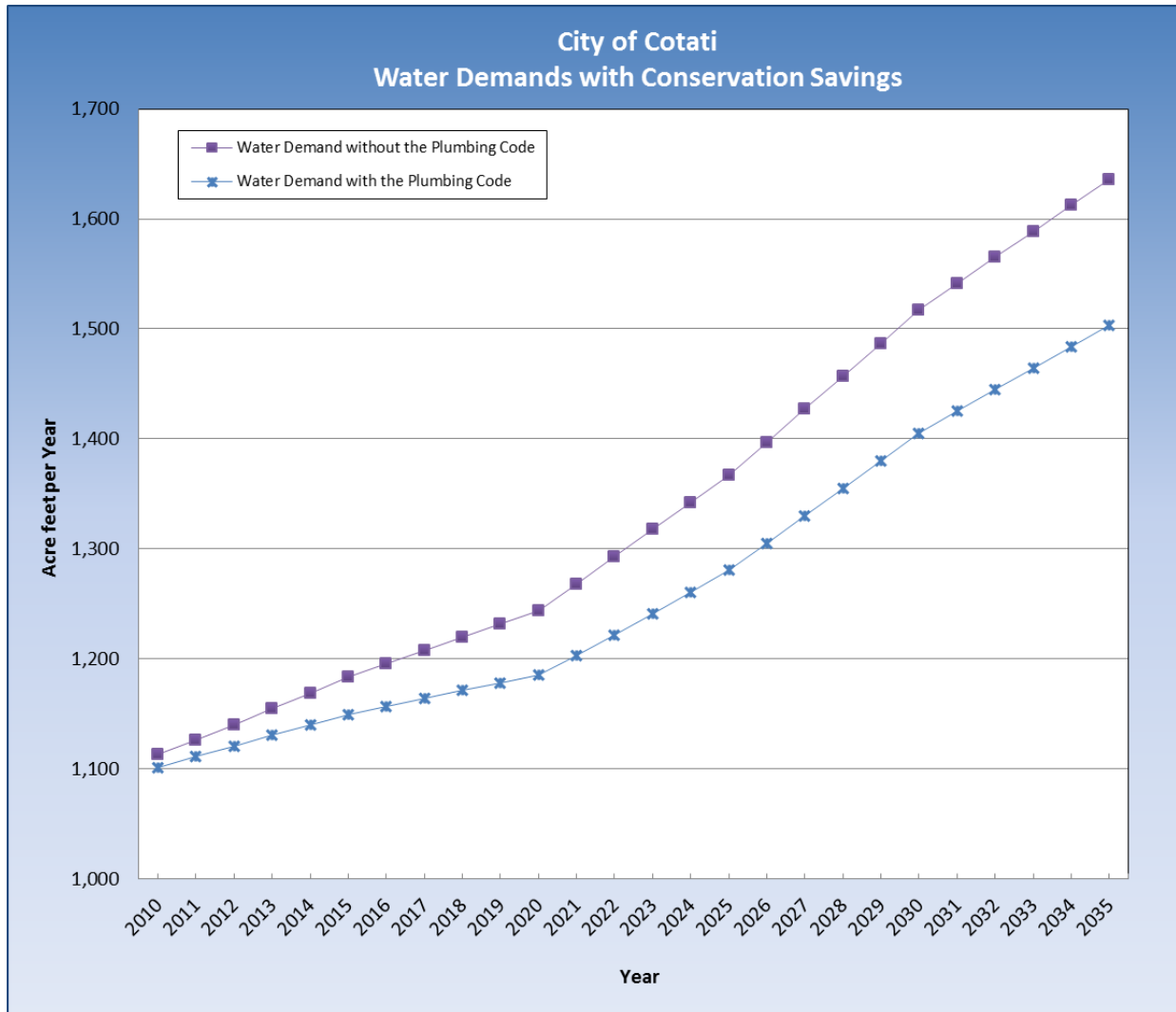


Table 4

Potable Water Use Projections for City of Cotati

City of Cotati Water Demands						
Water Demand (AFY)	2010	2015	2020	2025	2030	2035
Water Demand without the Plumbing Code	1,113	1,183	1,244	1,367	1,517	1,636
Water Demand with the Plumbing Code	1,101	1,150	1,185	1,281	1,405	1,503

*Data is not weather normalized. Total Water use is potable only. Does not include recycled water use. Recycled water use and projection are in a separate section in the UWMP.

4.5 Water Demand Projections – 2005 Urban Water Management Plan (UWMP) Format

The 2010 Urban Water Management Plan Guidance Document from the California Department of Water Resources is not planned to be released until after December 2010. Without the guidance document, the exact formatting of the tables for the 2010 UWMP are not known. Therefore, it was elected to place the demand data into the 2005 UWMP format.

Conversion of the Water Demand Projections Table and Graph to 2005 UWMP Format

The 2005 Urban Water Management Plan Guidance Document from the California Department of Water Resources (Ca DWR) requests that future demand information be in a specific format. Provided below are the five tables relating to future average day demands they requested. The demand projection shown is the “with Plumbing Code” demands and is otherwise the same as Table 4 and Figure 7. The demand projections in the Urban Water Management Plan appeared in the required DWR tables 2, 12, 13, 14, and 15 (2005 Plan requirement table numbers).

Urban Water Management Plan Tables for of 2005 UWMP

Table 5 below provides population projections for City of Cotati service area.

Table 5 (DWR Table 2) Population – Current and Projected

City of Cotati Current and Projected Population	
Year	Population
2010	7711
2015	8105
2020	8518
2025	8953
2030	9409
2035	9889

Current and Future Water Use by Customer Type

The current and projected number of connections and deliveries to the City’s water distribution system, by sector are identified below on Table 6.

Table 6 (DWR Table 12) Current and Projected Water Deliveries

City of Cotati Demands and Accounts By Customer Category (Based on Demand with Plumbing Code, excluding UFW)									
Year		Single Family	Multifamily	Commercial	Apt Irrigation	Irrigation	City and Irrigation	Agriculture	Total
2010	Number of Accounts	2,115	101	152	16	120	44	0	2,548
	Deliveries AF/Y	572	132	120	16	106	35	0	981
2015	# of accounts	2,224	106	169	16	133	46	0	2,693
	Deliveries AF/Y	588	135	130	16	118	37	0	1,024
2020	# of accounts	2,337	111	177	17	140	48	0	2,831
	Deliveries AF/Y	603	137	135	17	124	39	0	1,056
2025	# of accounts	2,456	117	223	18	176	51	0	3,041
	Deliveries AF/Y	620	141	166	18	156	41	0	1,142
2030	# of accounts	2,581	123	282	19	223	53	0	3,282
	Deliveries AF/Y	642	145	207	19	197	43	0	1,253
2035	# of accounts	2,713	129	321	20	253	56	0	3,492
	Deliveries AF/Y	667	150	234	20	224	45	0	1,340

Water Sales to Other Agencies

The City of Cotati does not currently sell water to any other agency. According to City of Cotati, all “outside sales” are local businesses and residents, and not to another agency.

Table 7 (DWR Table 13) Sales to Other Agencies

City of Cotati Sales to Other Agencies						
	N/A	N/A	N/A	N/A	N/A	N/A
Water Distributed (AFY)	N/A	N/A	N/A	N/A	N/A	N/A

Unaccounted-for Water and Additional Water Use

For this project unaccounted for water is defined to be the difference between water produced and water sold to customers. Unaccounted-for water use normally includes unmetered water use such as for fire protection and training, system and street flushing, sewer cleaning, construction, system leaks, meter inaccuracy, and unauthorized connections. Unaccounted-for water can also result from meter inaccuracies.

Table 8 (DWR Table 14) Additional Water Uses and Losses, AF/yr

City of Cotati Unaccounted for Water in AF/Yr						
	2010	2015	2020	2025	2030	2035
Unaccounted-for system losses (AFY)	121	125	130	139	152	163

Total Water Use

The total present and future water use for the system is shown in the table below.

Table 9 (DWR Table 15) Total Potable Water Use, AF/yr*

City of Cotati Total Demand with Plumbing Code in AF/Yr						
	2010	2015	2020	2025	2030	2035
Total Demand with Plumbing Code and UFW (AFY)	1,101	1,150	1,185	1,281	1,405	1,503

*Total Water use is potable only. Does not include recycled water use. Recycled water use and projection are in another section of the UWMP.

5. COMPARISON OF INDIVIDUAL CONSERVATION MEASURES

5.1 Selecting Conservation Measures to be Evaluated (Conservation Measure Screening)

An important step in updating the water conservation program is the review and screening of new water conservation measures. In 2005, a list of 75 potential conservation measures was developed by Maddaus Water Management from known technology that included devices or programs (e.g., such as a high efficiency toilet) that would save water if installed by a water retailer, contractor, or customer. These measures are considered to be beyond the Tier One measures. A description of the potential conservation measure was developed that addressed the methods through which the device or program will be implemented, including the distribution method, or mechanism, that would be used to activate the device or program.

A screening process was undertaken to reduce the number of measures to a more manageable number and to eliminate those measures that are not as well suited to the Marin-Sonoma County area as other

potential measures. Each potential measure was screened based on four qualitative criteria (below), scored on a scale of 1 to 5, with 5 being the most acceptable, and 20 being the maximum possible number of points for all criteria. The screening was completed by local conservation professionals, in a one day meeting in July 2005, facilitated by Maddaus Water Management.

Qualitative Criteria

The rating group used the following criteria to evaluate the measures:

- **Technology/Market Maturity** – Refers to whether the technology needed to implement the conservation measure, such as an irrigation control device, is commercially available and supported by the local service industry. A measure was scored low if the technology was not commercially available or high if the technology was widely available in the service area. A device may be screened out if it is not yet commercially available in the region.
- **Service Area Match** – Refers to whether the measure or related technology is appropriate for the area's climate, building stock, or lifestyle. For example, promoting Xeriscape gardens for multi-family or commercial sites may not be appropriate where water use analysis indicates little outdoor irrigation. Thus, a measure scored low in this category if it was not well suited for the area's characteristics and could not save water. A measure scored high in this criterion if it was well suited for the area and could save water.
- **Customer Acceptance/Equity** – Refers to whether retail customers within the wholesale customer service area would be willing to implement and accept the conservation measures. For example, would retail customers attend homeowner irrigation classes and implement lessons learned from these classes? If not, then the water savings associated with this measure would not be achieved and a measure with this characteristic would score low for this criterion. This criterion also refers to retail customer equitability (i.e., one category of retail customers receives benefit while another pays the costs without receiving benefits). Retail customer acceptance may be based on:
 - Convenience
 - Economics
 - Perceived fairness
 - Aesthetics
- **Relative Effectiveness of Measure Available** – Refers to the selection of the most effective measure if alternate conservation measures address the same end use (example – irrigation for single family customers). If the measures are equally effective the most appropriate was selected (e.g., the measure that was easier or less expensive to implement).

Measures with low scores were eliminated from further consideration, while those with high scores passed into the next evaluation phase (cost-effectiveness analysis using the DSS Model). To reduce the list to a more manageable number, normally a score of 17 or more was necessary to pass. The process reduced the measures to be evaluated further down to 22 new measures in addition to the 10 Tier One measures.

Upon inspection of the overall list of new measures it became apparent that some measures could be combined and others could be separated into two categories as follows:

- Measures that were voluntary and incentive based
- Measures that were regulatory and applied to new development only

This division was used to create two lists of measures that could be evaluated separately. Tier Two targets various types of customers and offers a range of incentives to enhance participation. New Development measures were originally targeted at single family homes (including town homes and condos), as this category represents the largest category of new development with the most water savings potential.

The following table presents the measure descriptions that were originally analyzed as part of the 2005 study for “Tier 2” and “New Development” (ND) as well as the new measures that the contractors selected for this analysis. We have not modified the Tier 2 and New Development measure descriptions from their original description other than to add information for Cal Green, SB 407, and the Model Water Efficient Landscape Ordinance. The Tier 1 measures follow the definition of the CUWCC BMPs.

Cal Green (New Development Building Code): MWM added the Cal Green requirements that effect all new development in the State of California after January 1, 2011. MWM modeled water savings from the Cal Green building code by adding Multifamily and Commercial customer categories as appropriate to the following six measures: Tier 2 – 13 (Urinals), ND 1 (Rain Sensors), ND 2 (Smart Controllers), ND 3 (HETs), ND 7 (High Efficiency Faucets and Showerheads) and ND 8 (Landscape Requirements). As this is a new development law and based on discussions with contractors it was assumed actual water savings seen by contractor would begin to occur in the year 2012. The new development ordinances for each contractor are listed in Table 10.

SB 407 (Plumbing Fixture Retrofit on Resale or Remodel): MWM included the new California Law SB 407 to the measure description table and in all of the contractors’ models as a new measure. In the model MWM worked carefully such that SB 407 takes into account the overlap with the plumbing code (natural replacement), Cal Green and rebate programs (such as through Tier 2-10 Toilets). SB 407 begins from the year 2017 in residential and 2019 in commercial properties. SB 407 program length continues until all the older high flush toilets have been replaced in each service area.

Tables 11, 12, 13 and 14 summarize the new measures selected for each contractor. Note that measures Tier 2-8, Tier 2-9 and Tier 2-11 were removed from this program at the request of all the contractors on August 2, 2010 for the following reasons:

- Measure Tier 2-8 was removed because new development regulations have changed significantly since this measure was analyzed in 2005 and the regulations require higher efficiency fixtures than this measure.
- Measure Tier 2-9 was removed as rebates for installing synthetic turf are incorporated into Measure Tier 2-2, Cash for Grass.
- Measure Tier 2-11 was removed because this measure is not cost-effective.

The removed measures are included in Table 13 for reference purposes only, but were not included in any of the DSS Model or any of the quantitative water saving calculations.

Table 10
New Development Ordinances

New Development Ordinances								
ND Measure	NMWD	City of Rohnert Park ¹	City of Cotati ²	City of Santa Rosa	Town of Windsor	City of Sonoma	Valley of the Moon WD	Draft Cal Green Requirement
Applicability (Customer Classes)	All	All	All	All	All	All	All	All
ND1-Rain Sensor Retrofit	2005	No	No	2010	2010 (SF>4 lots) & >2,500 sq ft/lot	No	2010, SF>5,000 sq ft	No
ND2-Smart Irrigation Controller	2005	No	2010	2010	2010 (SF>4 lots) & >2,500 sq ft/lot	No	2010, SF>5,000 sq ft	Yes
ND3- High Efficiency Toilets	2005	No	2009	2011	No	No	No	Yes
ND4- Dishwasher New Efficient	2005	No	2009	No	No	No	No	No
ND5-Clothes Washing Machine Requirement	2000	No	2009	No	No	No	No	No
ND6-Hot Water on Demand	No	No	No	No	No	No	No	No
ND7-High Efficiency Faucets and Showerheads	2006	No	2009	2011	No	No	No	Yes
ND8-Landscape and Irrigation Requirements	2004	2010 (State ordinance)	2010	SF since 2007. All other since 1993	2011 for landscapes > 2,500 sq ft (applies to all but SF<5 lots)	2010 (adopted ordinance planned to be adopted September 1, 2010, budgets w/ 60% ET	2010 for All except SF<5,000 sq. ft. and turf<600 sq ft	Yes
Urinals	2008	No	No	2011	No	2009	No	Yes
Source	NMWD Reg 15	Use Build it Green Checklist (Mandatory)	Use Build it Green Checklist (Mandatory)	Adopting Cal Green 2010	Adopting Landscape ordinance June 2010	Use Build it Green Checklist (Mandatory)	County ordinance effective Jan 1, 2010	State Reqmt; May take effect 2012

¹City of Rohnert Park has extensive green building ordinance requiring developers to select from a set of green building measures including some of the listed measures.

²City of Cotati ND-3 confirmed to start in 2009 based on July 27, 2010 with City of Cotati at the request of Damien O'Bid. Build It Green Checklist mandatory, beginning in the year 2004. The year 2009 was selected as a start date for 100% deployment of measures, as the measures can be selectively deployed providing the overall point minimum is achieved.

Table 11
Cal Green Building Code

Cal Green Building Code						
Building Class	Component	Effective Date[i]	Indoor Fixtures Included	Indoor Requirement	Landscaping & Irrigation Requirements	Are the Requirements Mandatory?
Residential	Indoor	1/1/2011	Toilets, Showers, Lavatory & Kitchen Faucets, Urinals	Achieve 20% savings overall below baseline		Yes
	Outdoor	1/1/2011			Provide weather adjusting controllers	Yes
Non Residential	Indoor	1/1/2011	Submeter leased spaces	Only if building >50,000 sq. ft. & if leased space use >100 gpd		Yes
			Toilets, Showers, Lavatory & Kitchen Faucets, Wash Fountains, Metering Faucets, Urinals	Achieve 20% savings overall below baseline		Yes
	Outdoor	1/1/2011			Provide water budget	> 1,000 sq ft. landscaped area
					Separate meter	As per Local or DWR ordinance
					Prescriptive landscaping requirements	> 1,000 sq ft. landscaped area
					Weather adjusting irrigation controller	Yes

[i] Effective date is 7/1/2011 for toilets

Table 12
Tier One Conservation Measures Evaluated in the DSS Model

Measure Number	Original CA BMP Number	Target Customer Category	Measure	Description
1	1	RSF, RMF	Residential Water Surveys - Indoor	This is the <u>indoor</u> component of indoor and outdoor water surveys for existing single-family and multi family residential customers. Normally those with high water use are targeted and provided customized report to homeowner.
2	1	RSF, RMF	Residential Water Surveys - Outdoor	This is the <u>outdoor</u> component of indoor and outdoor water surveys for existing single-family and multi family residential customers. Normally those with high water use are targeted and provided customized report to homeowner.
3	2	RSF, RMF	Residential Retrofit	Provide owners of pre-1992 homes with retrofit kits that contain easy-to-install low flow showerheads, faucet aerators, and toilet tank retrofit devices, until saturation reaches 75%.
4	5a	IRR	Water Budgets	90% of all irrigators of landscapes with separate irrigation accounts would receive a monthly or bi-monthly irrigation water use budget.
5	5b	IND	Large Landscape Conservation Audits	All public and private irrigators of landscapes larger than one acre would be eligible for free landscape water audits upon request.
6	6	RSF	Clothes Washer Rebate	Homeowners would be eligible to receive a rebate on a new water efficient clothes washer.
7	7	RSF, NRSF	Public Information Program	Public education would be used to raise awareness of other conservation measures available to customers. Programs could include poster contests, speakers to community groups, radio and television time, and printed educational material such as bill inserts, etc.
8	9	COM	Commercial Water Audits	High water use accounts would be offered a free water audit that would evaluate ways for the business to save water and money.
9	14	RSF	Single Family Residential ULF Toilet Rebate	Homeowners would be eligible to receive a rebate to replace an existing high volume toilet with a new water efficient toilet.
10	14	RMF	Multi family Residential ULF Toilet Rebate	Homeowners would be eligible to receive a rebate to replace an existing high volume toilet with a new water efficient toilet.

Notes:

RSF = Residential Single Family

RMF = Residential Multi Family

NRSF = New Residential Single Family

COM = Business

INS = Institutional

IND = Industrial

Table 13
Tier Two and New Development Conservation Measures Evaluated in the DSS Model

Measure Number	Name of Measure	Target Customer Category	Description
Tier 2-1	Rain-sensor (shut off device) retrofit on irrigation controllers	Existing Customers SF	Agency pays for the rain sensor, homeowner pays for the optional installation (\$35).
Tier 2-2	Cash for Grass (turf removal program)	Existing Customers SF, MF, CII	Provide a rebate for customers who remove irrigated turf grass and replace it with low water using plants. The rebate would require that an appropriate irrigation system be installed for the replacement landscaping. Limited to \$500 rebate at \$1.00 per square foot.
Tier 2-3	Financial Incentives for Being Below Water Budget	All Dedicated Irrigation Meter customers	For dedicated irrigation customers, link a landscape water budget to a retail water agency's rate schedule so that the dedicated irrigation meter customer pays less when their water use is at or under their water budget.
Tier 2-4	Financial Rebates for Irrigation Meters	Existing CII Customers with mixed water use (indoor and outdoor)	Provide financial incentives/rebates for selected permits and equipment to convert mixed use meters to a separate dedicated irrigation meter. Model implementation program after City of Santa Rosa's Service Split program. Utility will provide a water budget for the new irrigation meter.
Tier 2-5	Smart Irrigation Controller Rebates	Existing Customers SF, MF, CII, IRR	Provide an up to \$450 rebate for the purchase of a SMART irrigation controller and associated signal fees (up to \$150). Assume one controller for RSF and two for others. Minimum participant requirements: at least 500 sq ft of well maintained turf irrigated with an automatic irrigation control system.
Tier 2-6	Financial Incentives/ Rebates for Irrigation Upgrades	Existing Customers MF, CII, IRR, and SF for some contractors if requested as a new measure	For MF & CII customers with landscape provide rebates for selected types of irrigation equipment upgrade including rain sensors, rain harvesting, and grey water. Each contractor can include any equipment desired and allow the customers to select the items they prefer up to the maximum rebate value per customer. Water savings assumes a mixture of many different irrigation technologies. Model program after water agencies such as EBMUD or Contra Costa Water District or Santa Rosa.
Tier 2-7	Hotel retrofit (w/financial assistance) - CII Existing	Existing Customers: CII	Following a free water audit, offer the hotel a rebate for equipment identified that would save water. Provide a rebate schedule for certain efficient equipment such as air-cooled ice machines, steamers, washers, cooling towers, and spray rinse valves.
Tier 2-8 MEASURE REMOVED FROM 2010 ANALYSIS	Offer new accounts reduced connection fees for installing efficient process equipment for selected businesses (restaurants, laundry mat, food/groceries and hospital)	New Customers: CII	Offer reduced water and sewer connection fees to new facilities to install water efficient equipment in new facilities that goes above and beyond the building code requirements. Model program after Santa Rosa's BAT program.

Measure Number	Name of Measure	Target Customer Category	Description
Tier 2-9 MEASURE REMOVED FROM 2010 ANALYSIS	Synthetic Turf Rebate	Existing Customers: SF (North Marin only) , IRR	Provide a rebate for replacing existing turf with synthetic turf. Market program to all irrigation customers and single family for North Marin only.
Tier 2-10	High Efficiency Toilet (HET)	Existing Customers: SF & MF	Provide a rebate or voucher for the installation of a high efficiency toilet (HET). HET are defined as any toilet to flush 20% less than an ULFT and include dual flush technology. Rebate amounts would reflect the incremental purchase cost.
Tier 2-11 MEASURE REMOVED FROM 2010 ANALYSIS	Dishwasher New Efficient	Existing Customers: SF	Provide a rebate to encourage homeowners to replace old inefficient dishwashers with new efficient dishwashers (meeting certain water efficiency standards, such as gallons/load).
Tier 2-12	CII Rebates - replace inefficient water using equipment	Existing Customers: CII	Provide a rebate for a standard list of water efficient equipment. Included would be x-ray machines, icemakers, air-cooled ice machines, steamers, washers, spray valves, efficient dishwashers, replace once through cooling, add conductivity meters on cooling towers, etc.
Tier 2-13	0.5 gal/flush urinals in new buildings	New Customers: CII	Require that new buildings be fitted with 0.5 gpf or less urinals rather than the current standard of 1.0-gal/flush models.
ND1	Rain-sensor shut off device on irrigation controllers	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Require-sensor or rain shut off devices with all new automatic irrigation system installations on new homes.
ND2	Smart Irrigation Controller	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Require developers to provide the latest state of the art SMART irrigation controllers. These SMART controllers have on-site temperature sensors or rely on a signal from a central weather station that modifies irrigation times at least weekly.
ND3	High Efficiency Toilet (HET)	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Require new single family and multifamily residents to install a high efficiency toilet (HET). HET are defined as any toilet to flush 20% less than an ULFT and include dual flush technology.
ND4	Dishwasher New Efficient	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Require new single-family residents to install an efficient dishwasher (meeting certain water efficiency standards, such as gallons/load).
ND5	Clothes washing machines requirement for new residential	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Building departments would be responsible to ensure that an efficient washer was installed before new home occupancy.

Measure Number	Name of Measure	Target Customer Category	Description
ND6	Hot Water on Demand	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Require developers to equip new homes with a hot water on demand system or tankless hot water heaters, such as those made by Metland Systems and others. These systems use a pump placed under the sink to recycle water sitting in the hot water pipes to the water heater.
ND7	High efficiency faucets and showerheads	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Require developers to install Lavatory faucets that flow at no more than 1.5 gpm, kitchen faucets at 2.2 gpm, showerheads at 2.0 gpm
ND8	Landscape and irrigation requirements	New Customers: SF, MF and CII depending upon local ordinances and contractor request of new measures	Enforce a regulation that specifies that homes be landscaped according to Xeriscape principals and the Model Water Efficient Landscape Ordinance, with appropriate irrigation systems. (Combines with Smart Controller listed above). Goal is overall 25% reduction in irrigation water use.
New Measure	SB 407	Existing: SF, MF and CII	Measure will start in the year 2017 for SF accounts and 2019 for MF and CII accounts to coincide with the California State Law SB 407. The law includes working with the real estate industry to require a certificate of compliance be submitted to the City stating that, when a property is sold, information on whether or not indoor water fixtures are efficient was disclosed to the buyer.
Potential New Measure Selected by One or More Contractors	Rainwater harvesting	New Customers SF; Existing SF, MF	Provide a rebate (\$100 RSF and \$200 RMF) to assist a certain percentage of single family homeowners per year with installation of rain barrels or cisterns.
Potential New Measure Selected by One or More Contractors	Grey Water System Rebate	New Customers SF; Existing SF	Provide a rebate (up to \$500) to assist a certain percentage of single family homeowners per year to install gray water systems. Parts cost approx \$200, installation is approx \$400-\$500
Potential New Measure Selected by One or More Contractors	Conservation Pricing	Existing Customers: SF, MF, CII	Change Rate Structure to an inclining block rate and increase prices significantly periodically to maintain savings, such as every ten years.
Potential New Measure Selected by One or More Contractors	Submetering and Consumption Billing of Apartments and Mobile Homes	New Customers: MF	Require installation of submeters on all new MF and mobile home accounts unless the building has a central, circulating hot water system (which precludes a meter on all water going to each unit).

RSF = Residential Single Family

RMF = Residential Multi Family

NRSF = New Residential Single Family

COM = Business

INS = Institutional

IND = Industrial

Table 14
Conservation Measures Evaluated in the DSS Model

New Conservation Measures for Analysis (New for the 2010 analysis)							
Measure	City of Cotati	North Marin		City of Rohnert Park	City of Santa Rosa	City of Sonoma	Valley of the Moon Water District
		Water District					
Rainwater Harvesting Rebate					✓		
Grey Water System Rebate					✓		✓
Tiered Water Rates (Conservation Pricing)	✓					✓	
Submetering and Consumption Billing of Apartments and Mobile Homes - New and Existing			✓				
Add CII to New Development Requirements	✓	✓					✓
SB407 - Retrofit of High Efficiency Fixtures	✓	✓	✓	✓	✓	✓	✓
Add SF Residential to Irrigation System Upgrades (T2-6)		✓				✓	✓

5.2 Perspectives on Benefits and Costs

The determination of the economic feasibility of water conservation programs depends on comparing the costs of the programs to the benefits provided. The analysis was performed using the DSS Model. The DSS Model calculates savings at the end-use level; for example, the model determines the amount of water a toilet rebate program saves in daily toilet use for each single family account.

Present value analysis using constant 2010 dollars and a real discount rate of 3% is used to discount costs and benefits to the base year. From this analysis, benefit-cost ratios of each measure are computed. When measures are put together in programs, the model is set up to avoid double counting savings from multiple measures that act on the same end use of water. For example, multiple measures in a program may target toilet replacements. The model includes assumptions to apportion water savings between multiple measures.

Economic analysis can be performed from several different perspectives, based on which party is affected. For planning water conservation programs for utilities, the perspectives most commonly used for benefit-cost analyses include the utility and the community. The “utility” benefit-cost analysis is based on the benefits and costs to the water provider. The “community” benefit-cost analysis includes the utility benefit and costs together with account owner/customer benefits and costs. These include customer energy and other capital or operating cost benefits plus costs of implementing the measure, beyond what the utility pays.

The utility perspective offers two advantages for this analysis. First, it considers only the program costs that will be directly borne by the utility. This enables the utility to fairly compare potential investments for saving and supplying water. Second, because revenue shifts are treated as transfer payments, the analysis is not complicated with uncertainties associated with long-term rate projections and retail rate design assumptions. Because it is the water provider’s role in developing a conservation plan that is paramount in this study, the utility perspective was primarily used to evaluate elements of the plan.

The community perspective is defined to include the utility and the customer costs and benefits. Costs incurred by customers striving to save water while participating in conservation programs are considered, as well as the benefits received in terms of reduced energy bills (from water heating costs) and wastewater savings, among others. Other factors external to the utility, such as environmental effects and climate change, are not included in the benefit-cost analysis. Because these external factors are often difficult to quantify and are not necessarily under the control of the utility, they are therefore frequently excluded from economic analyses, including this one.

5.3 Present Value Parameters

The time value of money is explicitly considered. The value of all future costs and benefits is discounted to 2005 (the model start year) at the real interest rate of 3.0%. The DSS Model calculates this real interest rate, adjusting the current nominal interest rate (assumed to be approximately 6.1%) by the assumed rate of inflation (3.0%). Cash flows discounted in this manner are herein referred to as “Present Value” sums.

5.4 Assumptions about Measure Costs

Costs were determined for each of the measures based on industry knowledge, past experience and data provided by the City of Cotati. Costs may include incentive costs, usually determined on a per-participant basis; fixed costs, such as marketing; variable costs, such as the costs to staff the measures and to obtain and maintain equipment; and a one-time set-up cost. The set-up cost is for measure design by staff or consultants, any required pilot testing, and preparation of materials that will be used in marketing the measure. Measure costs were estimated for 30 years, (each year between 2005 and 2035). Costs were spread over the time period depending on the length of the implementation period for the measure and estimated voluntary customer participation levels.

Lost revenue due to reduced water sales is not included as a cost because the conservation measures evaluated herein generally take effect over a span of time that is sufficient to enable timely rate adjustments, if necessary, to meet fixed cost obligations.

5.5 Assumptions about Measure Savings

Data necessary to forecast water savings of measures include specific data on water use, demographics, market penetration, and unit water savings. Savings normally develop at a measured and predetermined pace, reaching full maturity after full market penetration is achieved. This may occur three to ten years after the start of implementation, depending upon the implementation schedule.

5.6 Assumptions about Avoided Costs

The most expensive source of water for almost all of the contractors, and in some cases the only source of water is the SCWA Russian River Supply. The price of the water to the contractors is set by SCWA every year and varies by contractor location, depending upon which aqueduct they draw from. Since 1990 the annual price of water has increased significantly. The annual rate of increase for 1989/1990 to 2010/11 has varied from 4.5 to 5.1% per year depending upon the aqueduct. Since 1990 the annual rate of inflation has increased 2.64% per year in the San Francisco Bay Area, as measured by the Consumer Price Index (CPI). Based on this data the price of SCWA water has increased faster than the CPI.

Therefore in evaluating the benefit cost ratio of conservation measures and programs it is appropriate to consider the net increase in benefits (i.e., the net increase in the avoided cost of water). Other costs, such as the cost of conservation will increase presumably at the CPI rate. Also the cost of conservation programs will be paid for with inflated dollars.

For this evaluation the avoided costs were escalated from the 2010/11 value to a projected 2025/26 value (15 years). The cost escalated was the 2010/11 current price plus a distribution cost of \$27.70 per acre-foot taken from pumping costs documented by North Marin Water District, which was the only contractor that had pumping costs readily available, and used for all contractors.

The net increase and the avoided costs used in this evaluation are listed below:

- Santa Rosa aqueduct contractors - 1.86% per year escalation or \$ 832 per acre-foot
- Petaluma aqueduct contractors - 1.81% per year escalation or \$ 827 per acre-foot
- Sonoma aqueduct contractors - 2.43% per year escalation or \$1,006 per acre-foot
- Windsor was escalated at the Santa Rosa rate to \$ 991 per acre-foot

This has the effect of raising the benefit-cost ratios in our evaluation by the amount that is roughly the percentage difference in the future vs. the current price of SCWA water. In our opinion this escalation represents a more realistic comparison of benefits and costs of conservation.

5.7 Measure Assumptions including Unit Costs, Water Savings, and Market Penetrations

Appendix A includes assumptions in the DSS Model for each of the following variables for all measures modeled:

- *Targeted Water User Group; End Use* – Water user group (e.g., single-family residential) and end use (e.g., indoor or outdoor water use).
- *Utility Unit Cost (for contractor)* – Cost of rebates, incentives, and contractors hired (by the utility) to implement measures.
- *Retail Customer Unit Cost* – Cost for implementing measures that is paid by retail customers (i.e., the remainder of a measure's cost that is not covered by a utility rebate or incentive).
- *Utility Administration and Marketing Cost* – The cost to the utility administering the measure, including consultant contract administration, marketing, and participant tracking. The mark-up is sufficient (in total) to cover local agency conservation staff time and general expenses and overhead.

The unit costs vary according to the type of account and implementation method being addressed. For example, a measure might cost a different amount for a residential single family account, than a residential multi family account, and for a rebate versus a direct installation implementation method. Typically water utilities have found that there are increased costs associated with achieving higher market saturation, such as more surveys per year. Appendix A shows the unit costs used in the study. The model calculates the annual costs based on the number of participants each year. The general formulas for calculating annual costs are:

Annual Utility Cost = Annual market saturation x total accounts in category x utility unit cost per account x (1+administration and marketing markup)

Annual Customer Cost = Annual number of participants x retail customer unit cost

Annual Community Cost = Annual utility cost + annual customer cost

5.8 Comparison of Individual Measures

Table 15 presents how much water the measures would save over 30 years, how much they would cost, and what cost of water saved is *if the measures were run on a stand-alone basis (i.e. without interaction or overlap from other measures that might address the same end use(s))*. Only the net or highest water savings for overlapping conservation measures was included in each program.

Economic indicators are defined below:

- *Utility costs*: those costs that the utility would spend include measure set-up, annual administration, and payment of rebates or purchase of devices or services as specified in the measure design.
- *Customer costs*: those costs customers would spend to participate in City of Cotati programs and maintaining its effectiveness over the life of the measure.
- *Community costs*: Community costs include utility and customer costs to implement measures.

The column headings in Table 15 are defined as follows:

- *Year 2035 Water Savings (AF/Yr)* = water savings in 2035 (AF/Yr) where AF/Yr = acre-feet per year.
- *Present Value of Water Utility Costs* = 30 year present value of the time stream of annual costs.
- *Utility Benefit-Cost ratio* = NPV of utility costs/NPV of utility benefits over 30 years.
- *Community Benefit-Cost ratio* = (NPV of Utility Benefits plus NPV of customer energy savings)/NPV of utility plus NPV of customer costs).
- *Utility Cost of Savings per Unit Volume (\$/AF, by cost category)* = NPV of Category Costs divided by 30-year volume of water saved.
- *Total Utility Cost for Five Years 2011-2015* = Total cost in dollars to run the program for the years 2011 to 2015 (five years). This is a five year cost often useful for short term financial budgeting purposes.

Table 15
Conservation Measure Cost and Savings

City of Cotati Conservation Measure Cost and Savings						
Measure Name	Year 2035 Water Savings (AFY)	Present Value of Water Utility Costs	Utility Benefit Cost Ratio	Community Benefit Cost Ratio	Utility Cost of Savings per Unit Volume (\$/AF)	Total Utility Cost for Five Years 2011-2015
CUWCC #1a - Residential Water Surveys - Interior	1.68	\$32,821	0.79	1.82	\$686	\$ 3,552
CUWCC #1b - Residential Water Surveys - Outdoor	2.36	\$32,287	1.02	0.92	\$523	\$ 3,420
CUWCC #5a - Large Landscape Water Budgets	26.99	\$131,743	2.13	2.13	\$239	\$ 23,920
CUWCC #6 - Washer Rebates	1.70	\$19,676	1.78	2.71	\$310	\$ 15,405
CUWCC #7 - Residential Public Education	6.29	\$73,797	1.28	2.67	\$421	\$ 16,276
CUWCC #9 - Commercial Water Audits	16.47	\$106,310	2.49	2.76	\$216	\$ 31,565
CUWCC #14a - RSF Toilet Replacement	0.00	\$26,190	2.24	0.90	\$248	\$ -
CUWCC #14b - RMF Toilet Replacement	0.00	\$2,220	3.66	1.46	\$149	\$ -
Tier 2 - 1 Rain Sensor Retrofit	1.91	\$9,322	1.81	0.75	\$257	\$ 2,148
Tier 2 - 2 Cash for Grass	0.64	\$7,511	0.99	0.55	\$492	\$ 6,129
Tier 2 - 3 Financial Incentives for Being Below Water Budget	28.28	\$233,814	1.07	0.15	\$428	\$ -
Tier 2 - 5a Smart Irrigation Controller Rebates - RSF	1.49	\$61,398	0.21	0.18	\$2,180	\$ 12,565
Tier 2 - 5b Smart Irrigation Controller Rebates - RMF, CII, IRR	6.21	\$80,531	0.73	0.46	\$635	\$ 20,758
Tier 2 - 6 Financial Incentives/Rebates for Irrigation Upgrades	2.42	\$14,228	1.45	0.81	\$313	\$ 2,843
Tier 2 - 10 High Efficiency Toilets	1.22	\$76,641	0.21	0.12	\$2,320	\$ 45,630
Tier 2 - 12 CII Rebates - Replace Inefficient Water Using Equipment	0.43	\$6,866	0.53	0.61	\$852	\$ 1,361
Tier 2 - 13 New Commercial Urinals	0.05	\$495	1.74	0.19	\$295	\$ 406
Tier 2 - ND1 Rain Sensor Retrofit	7.20	\$4,609	7.62	1.52	\$56	\$ 297
Tier 2 - ND2 Smart Irrigation Controller	12.53	\$5,048	12.93	0.35	\$34	\$ 816
Tier 2 - ND3 High Efficiency Toilets	0.77	\$2,447	4.70	0.21	\$108	\$ 2,282
Tier 2 - ND4 Dishwasher New Efficient	0.94	\$5,245	1.05	0.30	\$420	\$ 1,037
Tier 2 - ND5 Clothes Washing Machine Requirement	9.43	\$5,245	12.34	1.53	\$37	\$ 1,037
Tier 2 - ND6 Hot Water on Demand	12.11	\$4,857	12.94	0.74	\$33	\$ 595
Tier 2 - ND7 High Efficiency Faucets and Showerheads	10.59	\$6,767	8.48	6.14	\$52	\$ 1,177
Tier 2 - ND8 Landscape and Irrigation Requirements	8.35	\$6,561	6.63	0.03	\$65	\$ 945
Tier 2 - SB 407 Requirements	1.47	\$441	21.90	0.49	\$19	\$ -
Conservation Pricing Measure	74.71	\$113,423	3.94	5.31	\$114	\$ 1,361

6. RESULTS OF CONSERVATION PROGRAM EVALUATION

6.1 Selection of Measures for Programs

Table 16 provides a summary of which measures are included in each of the six draft alternative programs. The six packages are designed to illustrate a range of various measure combinations and resulting water savings.

These programs are not intended to be rigid programs but rather to demonstrate the range in savings that could be generated if selected measures were run together. In this step we account for a percent overlap in water savings (and benefits) and estimate combined savings and benefits from programs or packages of measures.

A description of each program evaluated follows. For most contractors Tier Two measures are modeled to commence in 2011. The only reason the measure would not start in 2011 is if an agency had submitted data showing activity in one of the Tier 2 programs from 2005 to 2009. Most agencies have shown significant activity on the Tier One measures since the model start year of 2005.

Program – Existing

Savings for the “Existing Program” include the measures that have been run during the time period of 2005 and 2009 as submitted by each individual contractor. For the City of Cotati, the following measures were included:

Existing Program Conservation Measures:

Existing Program Conservation Measures:

- CUWCC #1 - Residential Water Surveys - Interior
- CUWCC #1 - Residential Water Surveys - Outdoor
- CUWCC #2 - Plumbing Retrofit Kits
- CUWCC #3 – System Water Loss Reduction
- CUWCC #5a - Large Landscape Water Budgets
- CUWCC #5b - Large Landscape Audits
- CUWCC #6 - Washer Rebates
- CUWCC #7 - Residential Public Education
- CUWCC #9 - Commercial Water Audits
- CUWCC #14 - RSF Toilet Replacement
- Tier 2 – 1 Rain Sensor Retrofit
- Tier 2 - ND3 High Efficiency Toilets
- Tier 2 - ND4 Dishwasher New Efficient
- Tier 2 - ND5 Clothes Washing Machine Requirement
- Tier 2 - ND7 High Efficiency Faucets and Showerheads
- Tier 2 - ND8 Landscape and Irrigation Requirements

Program – Existing + New Measures

Savings for the “Existing Program + New Measures” include the measures that have been run during the time period of 2005 and 2009 as submitted by each individual contractor in addition to the three new measures evaluated for each contractor. The new measures for each contractor are listed in Table 14.

Program – Tier One Measures

This program was designed to be the future program with full compliance for “Tier One Measures” including all the CUWCC BMPs. Program water savings includes actual achievements for the years 2005 to 2009 and then projected participation rates starting in 2011 in accordance with those specified in the California Urban Water Conservation Council’s Memorandum Of Understanding, which may be higher (or lower) than you are currently achieving. If you continue to implement the BMPs as planned, your future demands will be reduced by the amount of savings from Tier One future measures.

Program - Tier One + New Development Measures

Savings for Tier One + New Development Measures were designed to isolate the effects of the New Development measures that would be implemented as well as the completion of Tier One measures. These eight New Development measures target new single family homes, multifamily homes, and commercial development based on the local ordinances or Cal Green as shown in Table 12 and 13.

Program – Tier One + Tier Two Measures

Savings for Tier One + Tier Two Measures includes 13 additional measures beyond the CUWCC BMPs. Tier One Future was designed to be the future program with full compliance for all the CUWCC BMPs. The participation rates starting in 2005 are in accordance with historical conservation efforts for the years 2005 to 2009. Then they proceed with the rate specified in the California Urban Water Conservation Council’s Memorandum Of Understanding, which may be higher (or lower) than you are currently achieving. If you continue to implement these measures, your future water demands will be reduced by the amount of conservation savings. Descriptions of the Tier Two measures are in Table 13 and cost and saving assumptions for each individual measure can be found in Attachment A. Note that due to increased regulations and additional research and analysis on conservation measures, measures Tier 2-8, Tier 2-9 and Tier 2-11 were removed from this program at the request of all the contractors on August 2, 2010.

Program: Tier One, Tier Two, New Development

Savings for Tier One, Tier Two, and New Development includes all analyzed conservation measures except for the “new measures” because the new measures are unique to each contractor and did not go through the original measure screening process as the other measures in 2005. Also note that measures that either saved a small amount of water or were not cost-effective (Benefit-Cost ratio less than 1.0 and a high cost of water saved) were included here. Some of the Tier Two measures are small programs in that the target number of accounts is very small. So even though they appear to be relatively expensive from a measure point of view, their impact on the overall program costs and savings is relatively minor. Note that due to increased regulations and additional research and analysis on conservation measures, measures Tier 2-8, Tier 2-9 and Tier 2-11 were removed from this program at the request of all the contractors on August 2, 2010.

Table 16
Conservation Measures Selected for Programs

City of Cotati Conservation Measures in each Program						
Measure Name	Program Existing	Program Existing & New	Program Tier One	Program Tier One & Tier Two	Program Tier One & ND	Program Tier One & ND & Tier Two
CUWCC #1a - Residential Water Surveys - Interior	✓	✓	✓	✓	✓	✓
CUWCC #1b - Residential Water Surveys - Outdoor	✓	✓	✓	✓	✓	✓
CUWCC #5a - Large Landscape Water Budgets	✓	✓	✓	✓	✓	✓
CUWCC #6 - Washer Rebates	✓	✓	✓	✓	✓	✓
CUWCC #7 - Residential Public Education	✓	✓	✓	✓	✓	✓
CUWCC #9 - Commercial Water Audits	✓	✓	✓	✓	✓	✓
CUWCC #14a - RSF Toilet Replacement	✓	✓	✓	✓	✓	✓
CUWCC #14b - RMF Toilet Replacement	✓	✓	✓	✓	✓	✓
Tier 2 - 1 Rain Sensor Retrofit				✓		✓
Tier 2 - 2 Cash for Grass				✓		✓
Tier 2 - 3 Financial Incentives for Being Below Water Budget				✓		✓
Tier 2 - 5a Smart Irrigation Controller Rebates - RSF				✓		✓
Tier 2 - 5b Smart Irrigation Controller Rebates - RMF, CII, IRR				✓		✓
Tier 2 - 6 Financial Incentives/Rebates for Irrigation Upgrades				✓		✓
Tier 2 - 10 High Efficiency Toilets				✓		✓
Tier 2 - 12 CII Rebates - Replace Inefficient Water Using Equipment				✓		✓
Tier 2 -13 New Commercial Urinals				✓		✓
Tier 2 - ND1 Rain Sensor Retrofit					✓	✓
Tier 2 - ND2 Smart Irrigation Controller	✓	✓			✓	✓
Tier 2 - ND3 High Efficiency Toilets	✓	✓			✓	✓
Tier 2 - ND4 Dishwasher New Efficient	✓	✓			✓	✓
Tier 2 - ND5 Clothes Washing Machine Requirement	✓	✓			✓	✓
Tier 2 - ND6 Hot Water on Demand					✓	✓
Tier 2 - ND7 High Efficiency Faucets and Showerheads	✓	✓			✓	✓
Tier 2 - ND8 Landscape and Irrigation Requirements	✓	✓			✓	✓
SB 407 Requirements (Plumbing Retrofit on Resale or Remodel)		✓				
Conservation Pricing Measure		✓				

NOTE – Due to increased regulations and additional research and analysis on conservation measures, Measures Tier 2-8, Tier 2-9 and Tier 2-11 were removed from analysis at the request of all the contractors

6.2 Results of Program Evaluation

Figure 8 shows annual water demand with no conservation, plumbing code only, and the six programs. Table 17 shows the savings in 5 year increments for all six programs. The savings in Table 17 are just from the conservation programs alone and do not include the plumbing code savings. The separate starting points for the demand with and without the plumbing code versus the conservation programs is directly correlated to the fact that the contractors have existing conservation programs active from 2005 and 2009 that are already saving water by the year 2010.

Figure 8
Long Term Demands with Conservation Programs

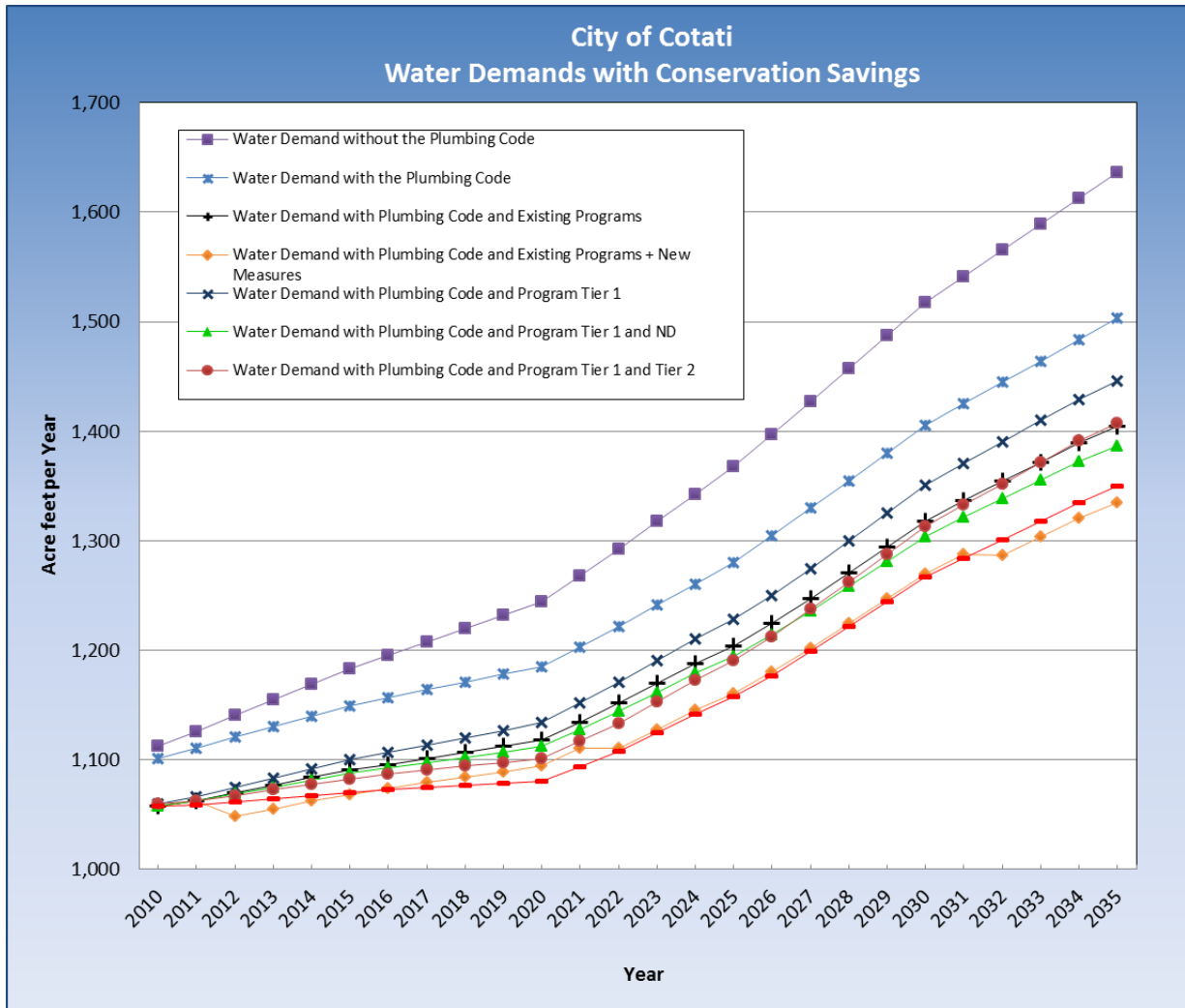


Table 17
Long Term Conservation Program Savings

City of Cotati Water Conservation Savings							Benefit Cost Ratio	Benefit Cost Ratio
Conservation Savings (AFY)	2010	2015	2020	2025	2030	2035	Utility	Community
Existing Programs	44	59	67	76	87	99	2.3	0.7
Existing Programs + New Measures	44	81	90	119	135	169	2.6	0.9
Program Tier 1	42	49	51	52	54	58	1.9	2.2
Program Tier 1 and ND	44	62	73	86	101	116	2.4	0.7
Program Tier 1 and Tier 2	42	67	84	90	92	96	1.2	0.6
Program Tier 1 and ND and Tier 2	44	79	105	123	138	154	1.5	0.5

Figure 9 shows how marginal returns change as more money is spent to achieve savings. As the figure shows the cost versus saving curve is starting to decline after Program Tier One + New Development. This means that the added cost of going from that Program to Tier One + Tier Two will save less water per unit expenditure. In other words there are diminishing returns when the curve starts to flatten out as Tier Two measures are added to the program. It is clear that the New Development measures are more

cost-effective to the utility than Tier Two measures. It is not to say that the Tier Two measures are a poor investment. The decision on which program is appropriate for each agency is dependent on many factors. Most recently it may be impacted by the goals set forth by SB7x-7 which calls for a reduction in per capita water use by 2020, which is independent of the economic analysis.

Figure 9
Present Value of Utility Costs versus Cumulative Water Saved

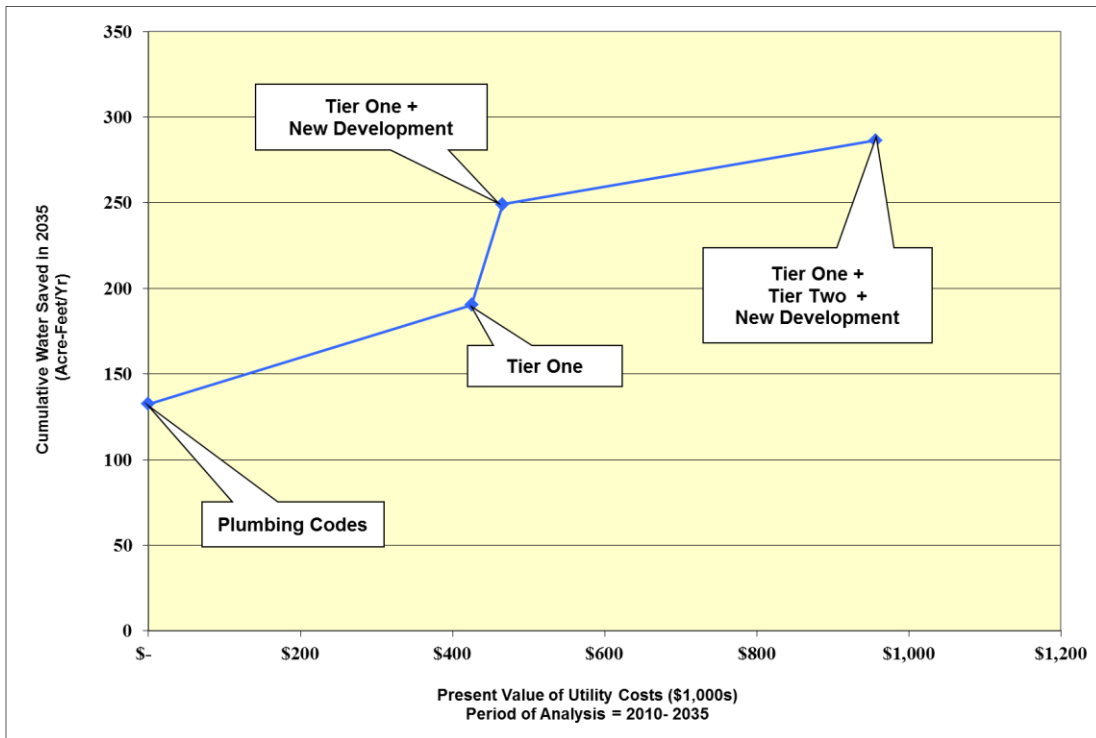


Table 18 presents key evaluation statistics compiled from the DSS Model. Assuming all measures are successfully implemented, projected water savings for 2030 in AF are shown, as are the costs of achieving this reduction. Water savings for programs have been shown for 2035 in Table 18.

The costs are expressed two ways.

1. Total present value over the analysis period,
2. The cost of water saved. Cost of water saved is presented two ways: for the utility and the total community (customer plus utility).

These cost parameters are derived from the annual time stream of utility, customer and community costs.

The water savings are expressed as a percentage of the projected 2035 demand. One column indicates the percentage of the new water demand in 2035 each program could provide. The new water needed by new customers over the full planning period is the difference between 2005 demand and 2035 demand without the plumbing code. The plumbing code is an additional savings that could be added on top of the water savings shown in Table 18. This allows the plumbing code savings percent and water savings in AF/Yr shown in Table 4 and to be additive to the conservation program savings in AF/Yr and percentages shown in Table 18.

Table 18
Comparison of Long-Term Conservation Programs – Utility Costs and Savings

City of Cotati Comparison of Conservation Program Costs and Savings										
Conservation Program	Water Utility Benefit-Cost Ratio	Community Benefit-Cost Ratio	2015 Water Savings (AFY)	2035 Water Savings (AFY)	2035 Indoor Water Savings (AFY)	2035 Outdoor Water Savings (AFY)	Total Water Savings as a % of Total Production in 2035*	Present Value of Water Utility Costs (\$1,000)	Total Utility Cost Five Years 2011-2015 (\$1,000)	Utility Cost of Water Saved (\$/AF)
Existing Program	2.27	0.74	59	99	42	56	6.57%	\$456	\$92	\$223
Existing Program + New Measures	2.56	0.91	81	169	59	110	11.23%	\$570	\$137	\$190
Tier One	1.88	2.22	49	58	21	37	3.85%	\$425	\$82	\$281
Tier One + Tier Two	1.25	0.74	67	96	23	73	6.38%	\$916	\$388	\$406
Tier One + New Development	2.42	0.64	62	116	54	63	7.75%	\$466	\$94	\$206
Tier One + Tier Two + New Development	1.54	0.51	79	154	55	99	10.24%	\$957	\$401	\$319

Notes:

- Present Value is determined using an interest rate of 3%
- Cost of water saved is present value of water utility cost divided by total 30-year water savings.
- * % of water saved refers to the demand without the plumbing code
- Total water savings in 2035 as a percent of production is relative to no plumbing code production
- Conversion 1 MGD is equal to 1120 AF/Yr

7. CONCLUSIONS

7.1 Relative Savings and Cost-Effectiveness of Programs

The City of Cotati service area has a relatively high portion of residential water use and a significant amount of outdoor water use. Consequently, residential conservation programs produce the most savings. City of Cotati's service area is not a heavy manufacturing sector so the conservation potential in the commercial sector is relatively low. Based on the assumed avoided cost of new water, water conservation programs are cost-effective. Overall conclusions are:

- The decrease in demand for Cotati compared to the water demand projections in the 2005 Demand and Water Conservation Measure Analysis completed by MWM was due to the reduction in employment projections and the change to lower water factors for each customer category used to project the water use for each customer category. The water factors decreased for all contractors compared to the 2005 study.
- Watersavings from implementation of the Tier One, Tier Two and New Development conservation programs would reduce water needs in 2035 by about 10.2 percent (154 AF/Yr as shown on Table 18) when compared to the water demands in 2035 without the plumbing code.
- Water savings from implementation of the Tier One conservation programs would reduce water needs in 2035 by about 3.85 percent (58 AF/Yr) as shown on Table 18) when compared to the water demands in 2035 without the plumbing code.
- For Future Tier One measures, more than half of the conservation potential in 2035 is in reducing outdoor use; the rest is indoor use reduction potential.
- The average cost of water saved over 30-years is lower than the current price of SCWA water. Thus measures that are cost-effective at today's water rates will be more so if SCWA rates rise in the future.
- Savings contributed by Tier Two measures alone are 38 acre-feet in 2035.
- Savings contributed by the New Development measures alone are 59 acre-feet in 2035.
- Benefit-cost ratios of program combinations range from 1.25 to 2.57 so all program combinations are cost-effective from the utility standpoint.
- The average cost of water saved for all of the programs from the utility standpoint (as shown on Table 18) is lower than the forecasted 2025 price of \$827 per AF.
- The cost for the new development measures is largely funded by the builders of the new homes, which tends to reduce the overall cost to the utility for all measures.

Appendix A - Assumptions for Water Conservation Measures Evaluated in the DSS Model

	BMP 1a Residential Audits	BMP 1a Residential Audits	BMP 1b Residential Audits	BMP 1b Residential Audits	BMP 2 Plumbing Retrofits
Account Category	RSF	RMF	RSF	RMF	RSF / RMF
Affected End Uses	Internal	Internal	External	External	Toilets, Faucets, Showers
Percent Reduction in Water Use	5%	5%	10%	10%	5%/5%/21%
CUWCC MOU Sign-on Year	2001	2001	2001	2001	2001
Evaluation Start Year	2005	2005	2005	2005	2005
Required Interventions Starting in 2005 (Accounts)	127	2	127	2	0
Market Penetration by End Of Program, %	15	15	15	15	75
Measure Life (years)	7	7	7	7	Permanent
Initial Cost	\$ -	\$ -	\$ -	\$ -	\$ -
Utility Unit Cost, per site one time cost	\$40.00	\$80.00	\$40.00	\$50.00	\$30.00
Customer Unit Cost to achieve savings	\$10.00	\$30.00	\$5.00	\$20.00	\$0
Administration Cost, percent of unit cost	25%	25%	25%	25%	10%
Affected Units	dwelling unit	dwelling unit	dwelling unit	dwelling unit	1992 and older dwelling units
Comments	Assume audits are renewed every 7 years to maintain water savings				BMP Complete

Notes:

RSF = Residential Single Family

RMF = Residential Multi Family

BUS/COM= Commercial

IND = Industrial

IRR = Dedicated irrigation meters

INS = Institutional/Public, buildings / grounds owned by the Water Utility or City

NRSF = New Single Family Homes

GOV = Government

	BMP 5a Water Budgets	BMP 5b Water Audits	BMP 6 Washer Rebates	BMP 7 Public Education	BMP 9 CII Audits	BMP 14 Toilet Rebates
Account Category	IRR	BUS	RSF	RSF/RMF	BUS/INS	RSF/RMF
Affected End Uses	Irrigation	Irrigation	Laundry	All	All	Internal
Percent Reduction in Water Use	15%	15%	34%	1%	12%	60%
CUWCC MOU Sign-on Year	2001	2001	2001	2001	2001	2001
Evaluation Start Year	2005	2005	2005	2005	2005	2005
Required Interventions Starting in 2005 (Accounts)	95	0	0	1,777	31	105/3
Market Penetration by End Of Program, %	90	15	4.8	100	10	Match resale rate
Measure Life (years)	10	10	Permanent	2	Permanent	Permanent
Initial Cost	\$ -	\$ -	\$ -	\$ -	\$ -	NA
Utility Unit Cost, per site one time cost	\$400.00	\$1,500.00	\$75.00	\$2.50	\$4,000.00	\$50
Customer Unit Cost to achieve savings	\$ -	\$1,000.00	\$200.00	\$ -	\$2,000.00	\$75
Administration Cost, percent of unit cost	15%	30%	30%	25%	50%	included
Affected Units	Irrigation accounts	large landscape accounts	per dwelling unit	per dwelling unit	CII accounts	per toilet
Comments	Assume audits are renewed every 10 years to maintain water savings		BMP 6 complete			

Notes:

RSF = Residential Single Family

RMF = Residential Multi Family

BUS/COM= Commercial

IND = Industrial

IRR = Dedicated irrigation meters

INS = Institutional/Public, buildings / grounds owned by the Water Utility or City

NRSF = New Single Family Homes

GOV = Government

Measure	T2 - 1	T2 - 2	T2 - 3	T2 - 4	T2 - 5a	T2 - 5b	T2 - 6
	Rain-sensor (shut off device) retrofit on irrigation controllers	Cash for Grass (turf removal program)	Financial Incentives for Being Below Water Budget	Financial Rebates for Irrigation Meters	Smart Irrigation Controller Rebates	Smart Irrigation Controller Rebates	Financial Incentives/ Rebates for Irrigation Upgrades
Applicable Customer Classes	SF	Existing Customers SF, MF, CII	IRR	--	SF	Existing Customers MF, CII, IRR	Existing Customers MF, CII, IRR
Applicable End Uses	Irrigation	Irrigation	Irrigation	--	Irrigation	Irrigation	Irrigation
Market Penetration by End Of Program	10%	1%	100%	10%	5%	20%	10%
Water Use Reductions For Targeted End Uses	9%	50%	15%	15%	15%	15%	15%
Program Length, years	5	5	10	5	10	10	15
Measure Life, years	10	permanent	permanent	permanent	21	permanent	permanent
Utility Unit Cost for SFaccounts, \$/unit	\$ 20.00	\$ 500.00	\$ 25,000.00	\$ -	\$ 450.00	\$ -	\$ -
Utility Unit Cost for MF accounts, \$/unit	--	\$ 500.00	\$ -	\$ -	\$ -	\$ 900.00	\$ -
Utility Unit Cost for non-Res accounts, \$/unit	--	\$ 500.00	\$ -	\$ 500.00	\$ -	\$ 900.00	\$ 500.00
Customer Unit Cost. \$/unit	\$ 35.00	\$ 500.00	\$ 10,000.00	\$ 500.00	\$ 100.00	\$ 100.00	\$ 500.00
Annual Utility Admin & Marketing Cost	25%	25%	35%	25%	30%	30%	25%

Notes:

RSF = Residential Single Family

RMF = Residential Multi Family

BUS/COM= Commercial

IND = Industrial

IRR = Dedicated irrigation meters

INS = Institutional/Public, buildings / grounds owned by the Water Utility or City

NRSF = New Single Family Homes

GOV = Government

Measure	T2 - 7	T2 - 10	T2 - 12	T2 - 13
	Hotel retrofit (w/financial assistance) - CII Existing	High Efficiency Toilet (HET)	CII Rebates - replace inefficient water using equipment	0.5 gal/flush urinals in new buildings
Applicable Customer Classes	--	SF, MF	CII	COM New
Applicable End Uses	--	Toilet end use	Process end use	COM Urinal
Market Penetration by End Of Program	20%	20%	10%	100%
Water Use Reductions For Targeted End Uses	20%	45 to 55%	10%	65 to 75%
Program Length, years	15	10	15	30
Measure Life, years	permanent	permanent	permanent	permanent
Utility Unit Cost for SFaccounts, \$/unit	\$ -	\$ 150.00		\$ 50.00
Utility Unit Cost for MF accounts, \$/unit	\$ -	\$ 150.00		
Utility Unit Cost for non-Res accounts, \$/unit	\$ 100.00		\$ 500.00	
Customer Unit Cost. \$/unit	\$ 200.00	\$ 150.00	\$ 1,000.00	\$ 500.00
Annual Utility Admin & Marketing Cost	25%	35%	30%	25%

Notes:

RSF = Residential Single Family

RMF = Residential Multi Family

BUS/COM= Commercial

IND = Industrial

IRR = Dedicated irrigation meters

INS = Institutional/Public, buildings / grounds owned by the Water Utility or City

NRSF = New Single Family Homes

GOV = Government

Measure	ND 1	ND 2	ND 3	ND 4	ND 5	ND 6	ND 7	ND 8
	Rain-sensor shut off device on irrigation controllers	Smart Irrigation Controller	High Efficiency Toilet (HET)	Dishwasher New Efficient	Clothes washing machines requirement for new residential	Hot Water on Demand	High efficiency faucets and showerheads	Landscape and irrigation requirements
Applicable Customer Classes*	Varies	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Applicable End Uses	Irrigation	Irrigation	Toilet end use	Dishwasher end use	Clothes Washer end use	Faucet and shower end use	Faucet and shower end use	Irrigation
Market Penetration by End Of Program	100%	100%	100%	100%	100%	100%	100%	100%
Water Use Reductions For Targeted End Uses	9%	15%	50 to 55%	34%	50%	14.2 gpd per house	15%	10%
Program Length, years	30	30	30	30	30	30	30	30
Measure Life, years	permanent	permanent	permanent	permanent	permanent	permanent	permanent	permanent
Utility Unit Cost for SFaccounts, \$/unit	\$ 12.50	\$ 12.50	\$ 12.50	\$ 12.50	\$ 12.50	\$ 12.50	\$ 12.50	\$ 12.50
Utility Unit Cost for MF accounts, \$/unit	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Utility Unit Cost for non-Res accounts, \$/unit	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Customer Unit Cost. \$/unit	\$ 55.00	\$ 500.00	\$ 300.00	\$ 400.00	\$ 500.00	\$ 700.00	\$ 50.00	\$ 3,000.00
Annual Utility Admin & Marketing Cost	10%	10%	10%	10%	10%	10%	10%	10%

Notes:

RSF = Residential Single Family

RMF = Residential Multi Family

BUS/COM= Commercial

IND = Industrial

IRR = Dedicated irrigation meters

INS = Institutional/Public, buildings / grounds owned by the Water Utility or City

NRSF = New Single Family Homes

GOV = Government

*Customer class varies depending upon local ordinances, Cal Green and contractor request of new measure or planned ordinances

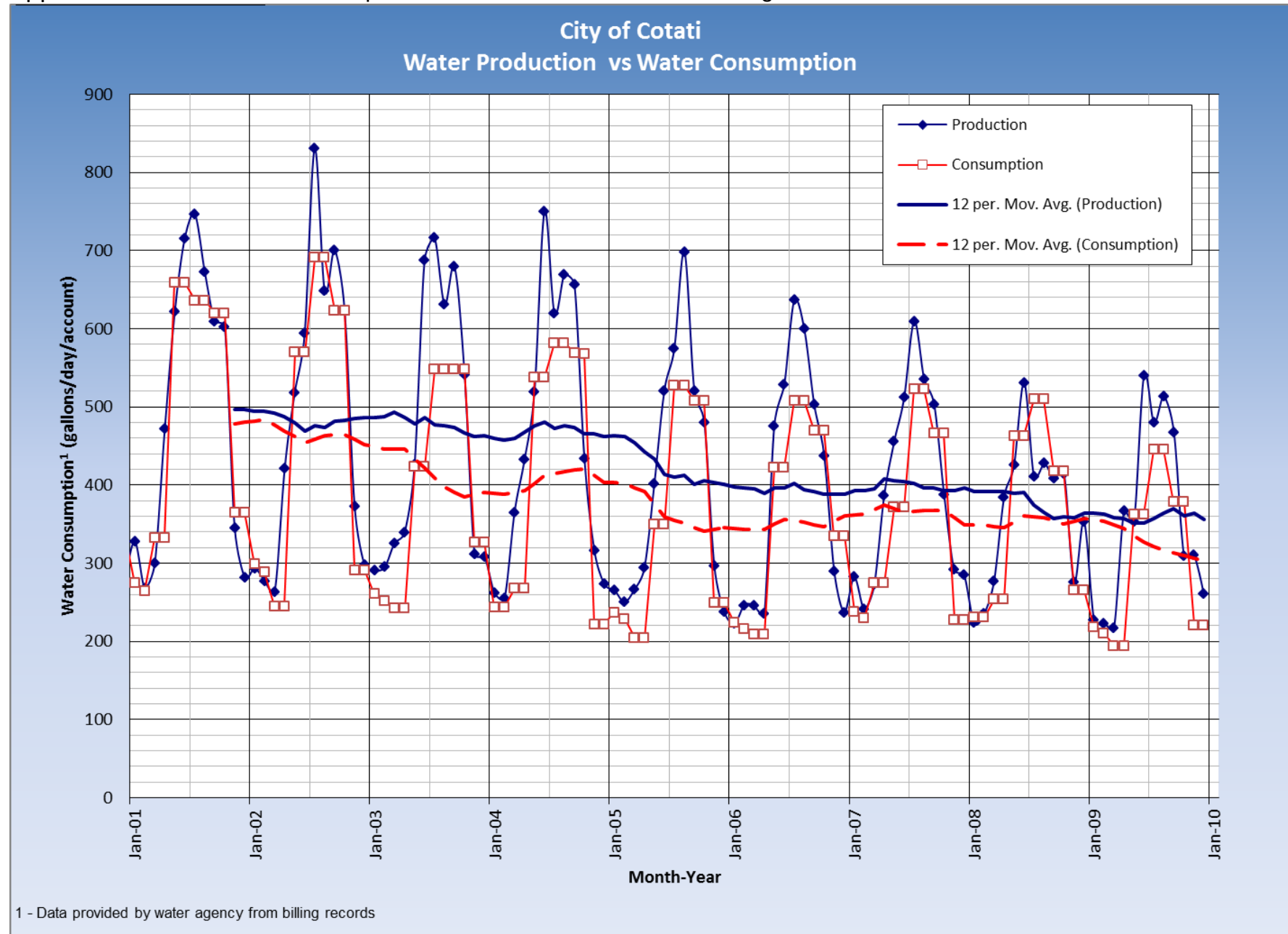
Fixture Replacement SB 407	
Pre-1994 Existing Accounts	
Toilet, urinal, shower, lavatory faucet	
4% SF, 2% MF and CII	
1% 2017-2020 SF, 1% 2019-2020 MF, 1% CII 2019-2020	
Varies	
2014	
2020	
7	
Permanent	
\$	25
\$	25
\$	25
Varies	
Varies	
Varies	
25%	
Dwelling unit or CII account	
Measure will start in the year 2017 (SF) and 2019 (CII) to coincide with the California State Law SB 407. Work with the real estate industry to require a certificate of compliance be submitted to the City that the property and efficient fixtures were either already there or were installed at the time of sale, before close of escrow. Consider allowing this certification to be made as a part of the conventional private building inspection report process.	

Notes:

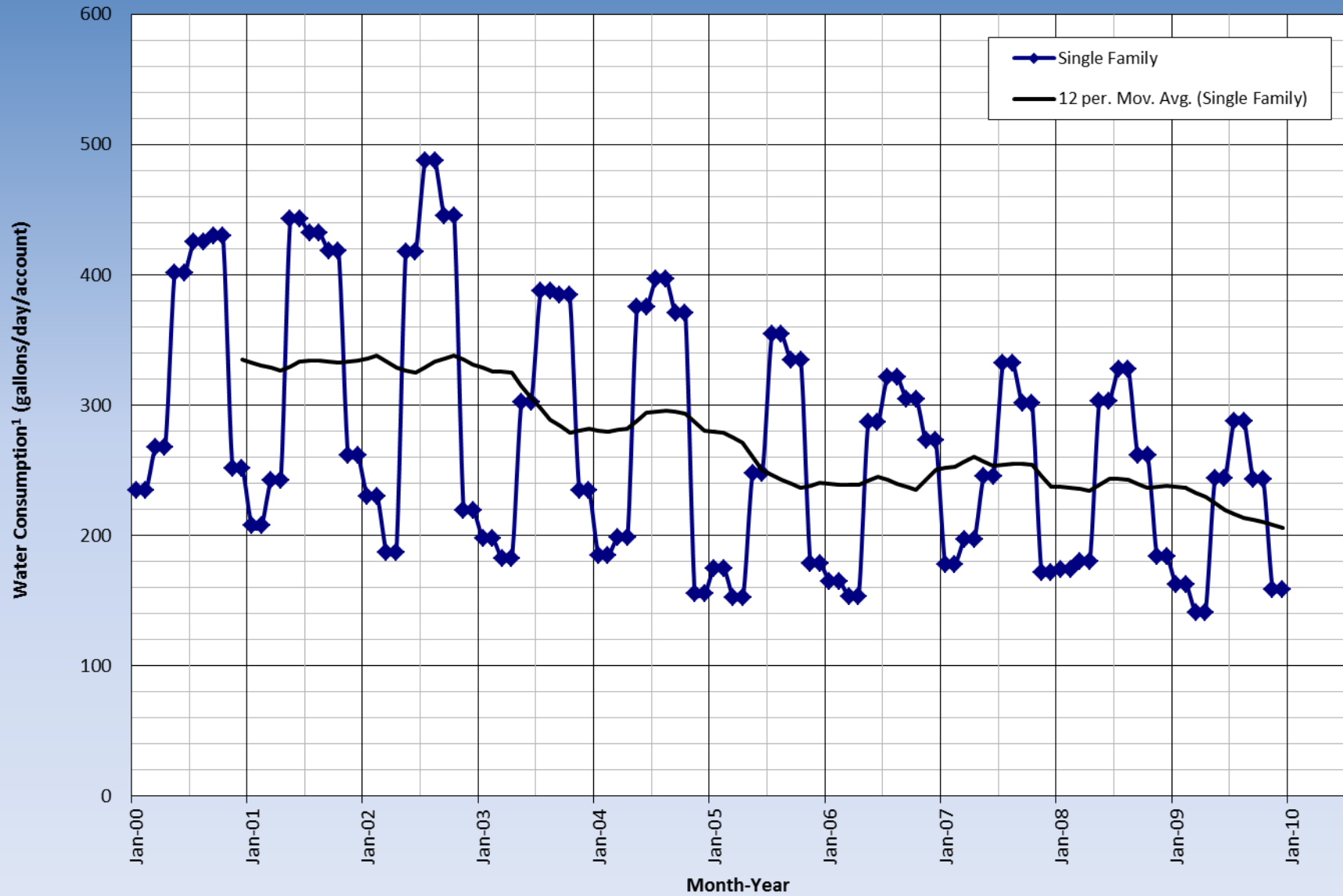
RMF = Residential Multi Family

CII = Commercial, Industrial and Institutional

Appendix B - Water Use Data Graphs for Production and Customer Categories

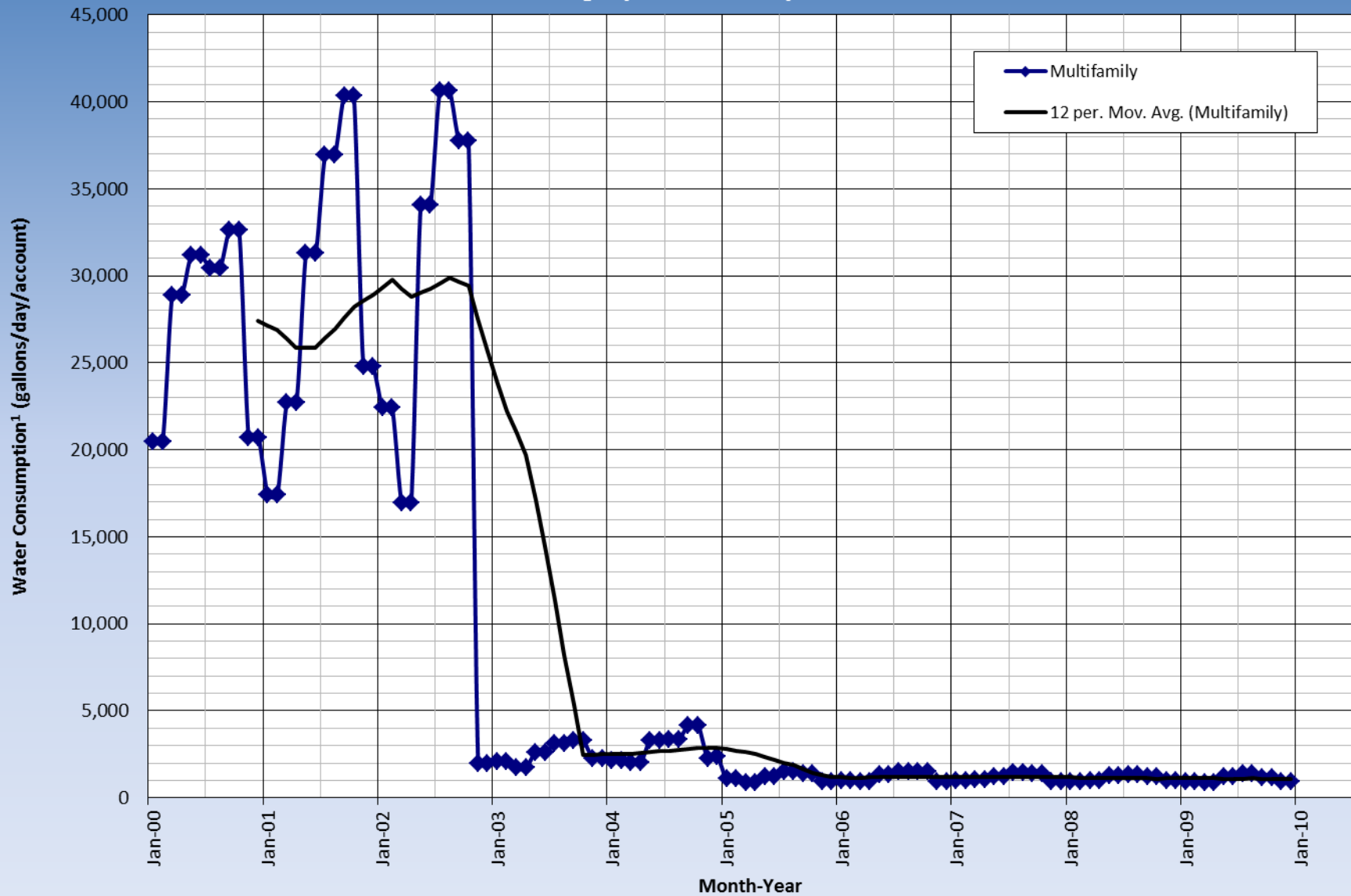


City of Cotati
Customer Category : Single Family Residential



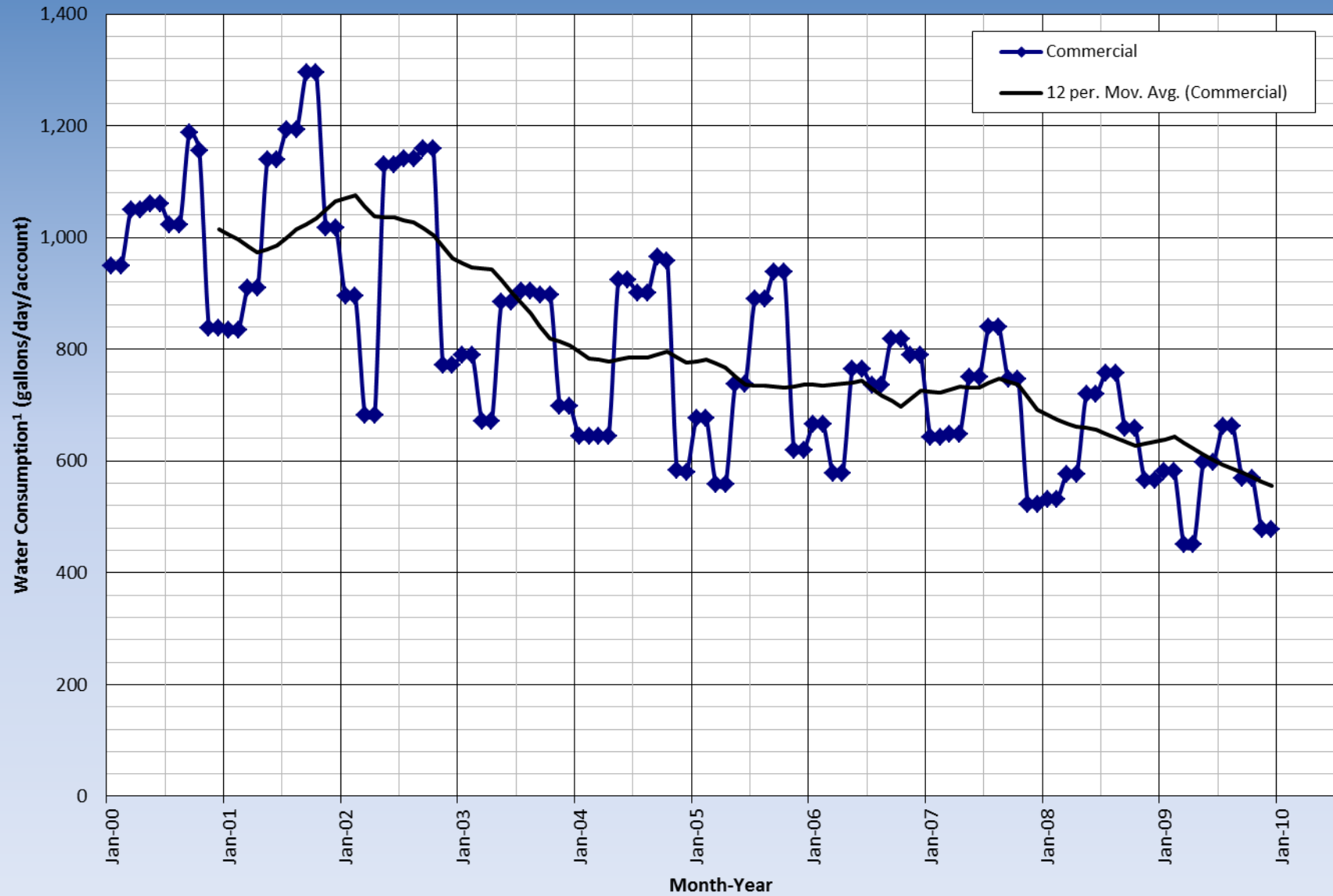
1 - Data provided by water agency from billing records

City of Cotati Customer Category : Multifamily Residential



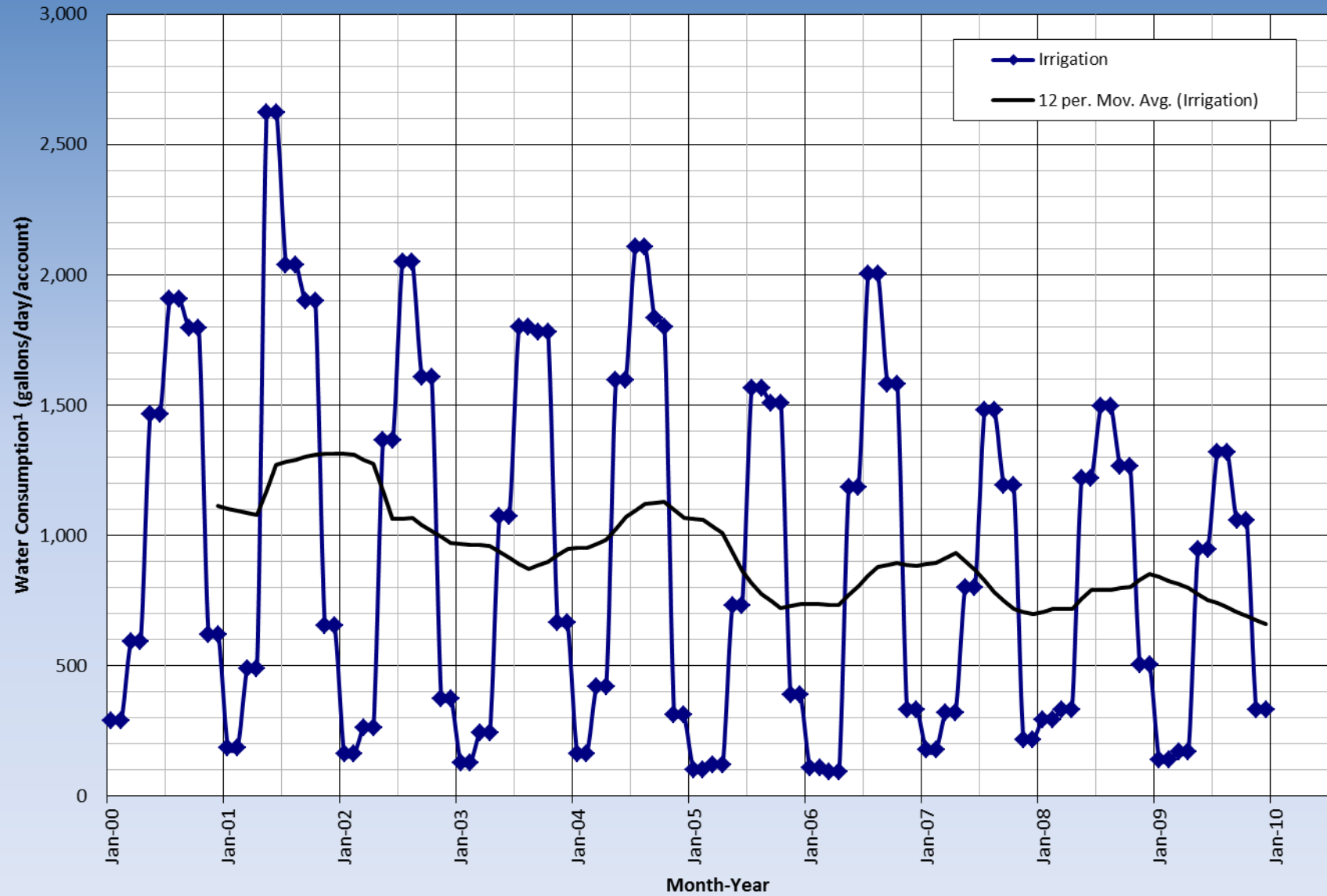
1 - Data provided by water agency from billing records

City of Cotati Customer Category : Commercial



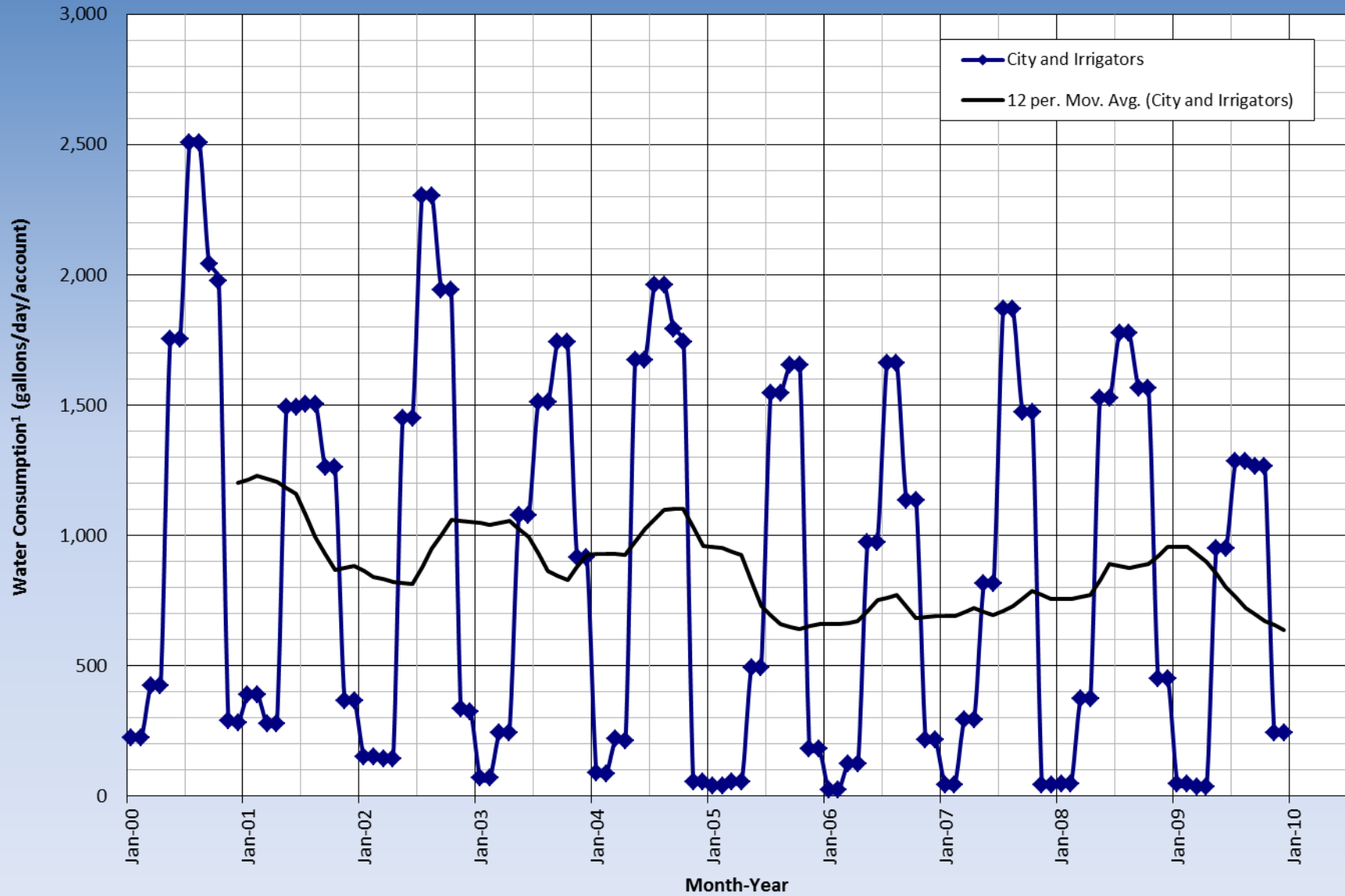
1 - Data provided by water agency from billing records

City of Cotati Customer Category : Irrigation



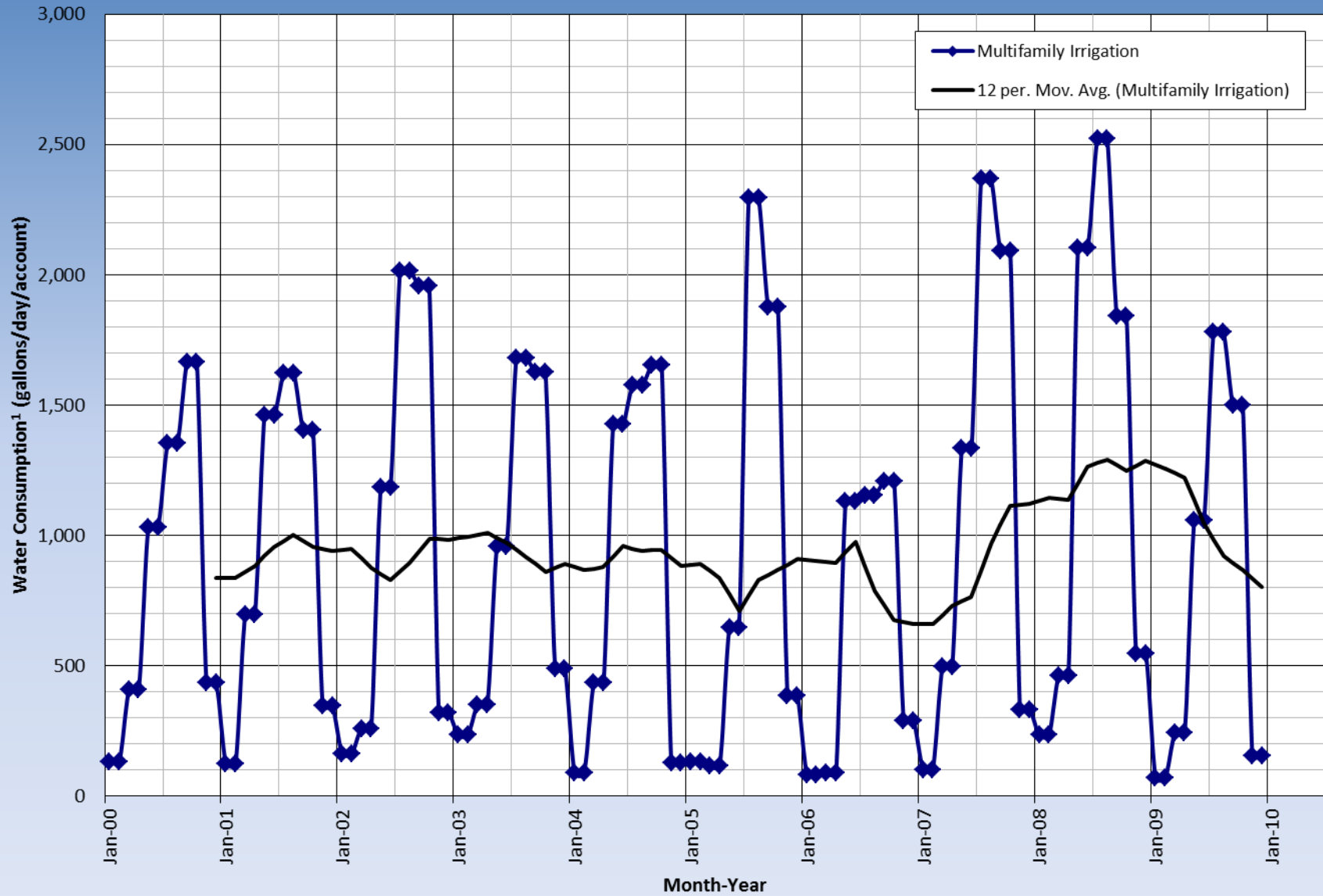
1 - Data provided by water agency from billing records

City of Cotati Customer Category : City and Irrigators



1 - Data provided by water agency from billing records

City of Cotati
Customer Category : Multifamily Irrigation



1 - Data provided by water agency from billing records

APPENDIX B – GROUNDWATER WELL INFORMATION

Tuesday, July 27, 2010

Well 1A Pump Data

Rated Total Head (ft.)	140
Capacity at Rated Head (gpm)	500
Min. Pump Efficiency (80%)	80
Max. Pump Speed (rpm)	1,800
Rated Motor Size (hp)	25
Column and Suction Pipe Dia. (inches)	6
Pump Discharge Connection Size (inches)	6
Line Shaft Diameter (inches)	1.4
Design Pumping Water Level, below ex. Ground Surface	135

PUMP DATA SHEET Turbine 60 Hz



Company: Western HYdro Corporation Customer: Groundwater Pump and Well

Name: Carlos Moreno

Date: 07/24/09

Order No:

Pump:

Size: 10WAHC (7 stages)

Type: Lineshaft

Synch speed: 1800 rpm

Curve: E6410WAPC1

Specific Speeds:

Ns: 1695

Pump Notes for Standard Sizes:

Suction Size-6" Discharge Sizes-4",6",8"

Vertical Turbine:

Bowl size: 9.5 in

Max lateral: 0.63 in

Thrust K factor: 4.65 lb/ft

Search Criteria:

Flow: 380 US gpm

Head: 380 ft

Fluid:

Water

Density: 62.25 lb/ft³

Viscosity: 1.105 cP

NPSHa: --- ft

Temperature: 60 °F

Vapor pressure: 0.2563 psi a

Atm pressure: 14.7 psi a

Motor:

Standard: NEMA

Size: 60 hp

Speed: 1800

Pump Limits for Standard Construction:

Temperature: 120 °F

Pressure: 375 psi g

Sphere size: 0.45 in

Sizing criteria: Max Power on Design Curve

--- Data Point ---

Flow: 380 US gpm

Head: 382 ft

Eff: 84.3%

Power: 43.4 hp

NPSHr: 9.04 ft

-- Design Curve --

Shutoff Head: 428 ft

Shutoff dP: 185 psi

Min Flow: --- US gpm

BEP: 84.5% eff

@ 372 US gpm

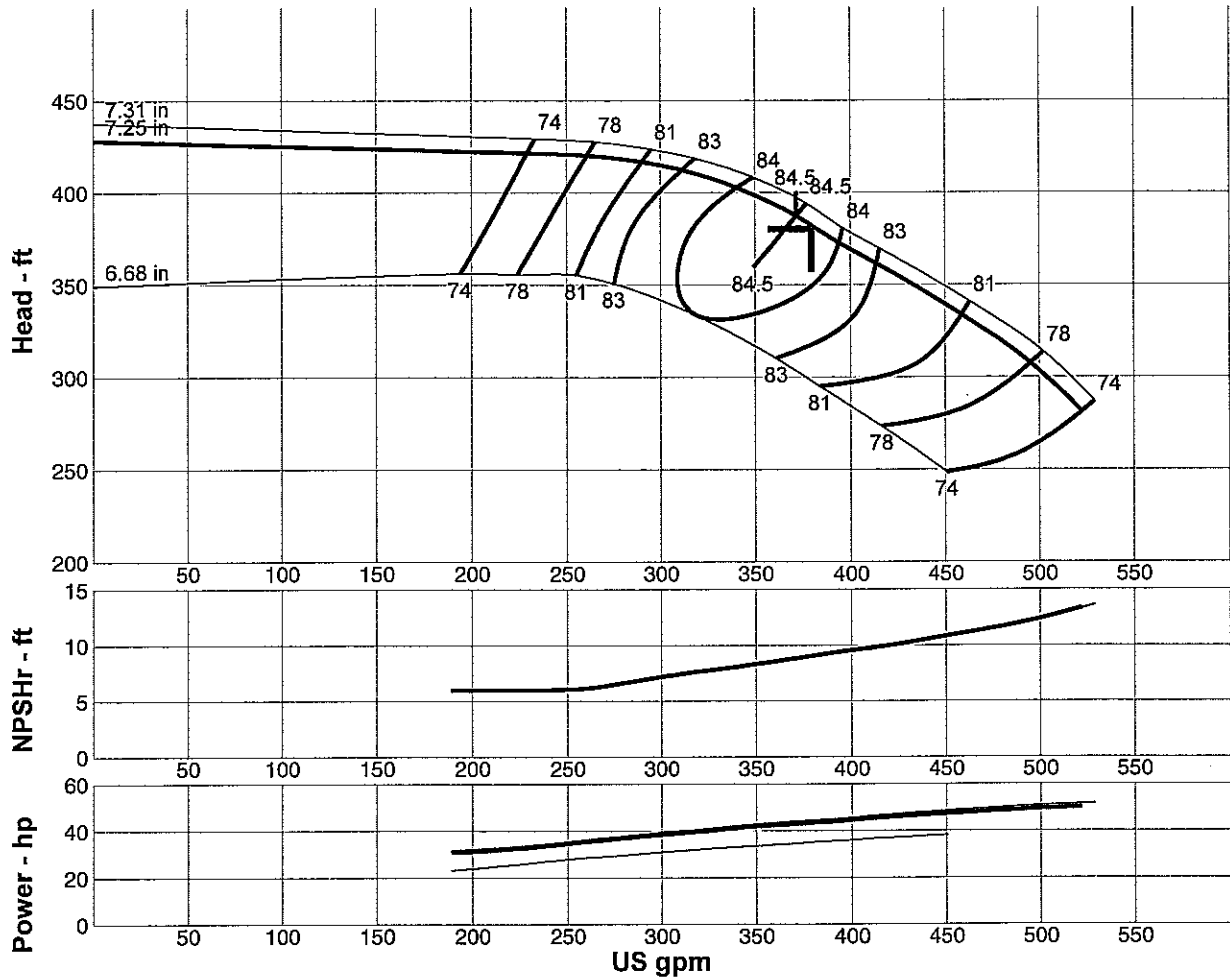
NOL Pwr: 50.1 hp

@ 522 US gpm

-- Max Curve --

Max Pwr: 51.8 hp

@ 529 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
456	1770	335	81.1	47.6	11
380	1770	382	84.3	43.4	9.04
304	1770	414	82.3	38.6	7.25
228	1770	421	73.8	32.9	6
152	1770	---	---	---	---

PUMP DATA SHEET Turbine 60 Hz



Company: Midway Industrial
Name:
Date: 05/13/10

Customer:
Order No:

Pump:

Size: 11CLC (7 stages)

Type: Lineshaft
Synch speed: 1800 rpm

Curve: E3142-2

Specific Speeds:

Speed: 1770 rpm
Dia: 7.9375 in

Ns: 2230

Pump Notes for Standard Sizes:
Suction Size-8" Discharge Sizes-6",8". Curves are certified for water at 60°F only. Consult factory for performance with any other fluid.

Vertical Turbine:

Bowl size: 11 in
Max lateral: 0.75 in
Thrust K factor: 7 lb/ft

Search Criteria:

Flow: 700 US gpm

Head: 380 ft

Fluid:

Water
Density: 62.25 lb/ft³
Viscosity: 1.105 cP
NPSHa: --- ft

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA

Size: 100 hp
Speed: 1800

Sizing criteria: Max Power on Design Curve

Pump Limits for Standard Construction:

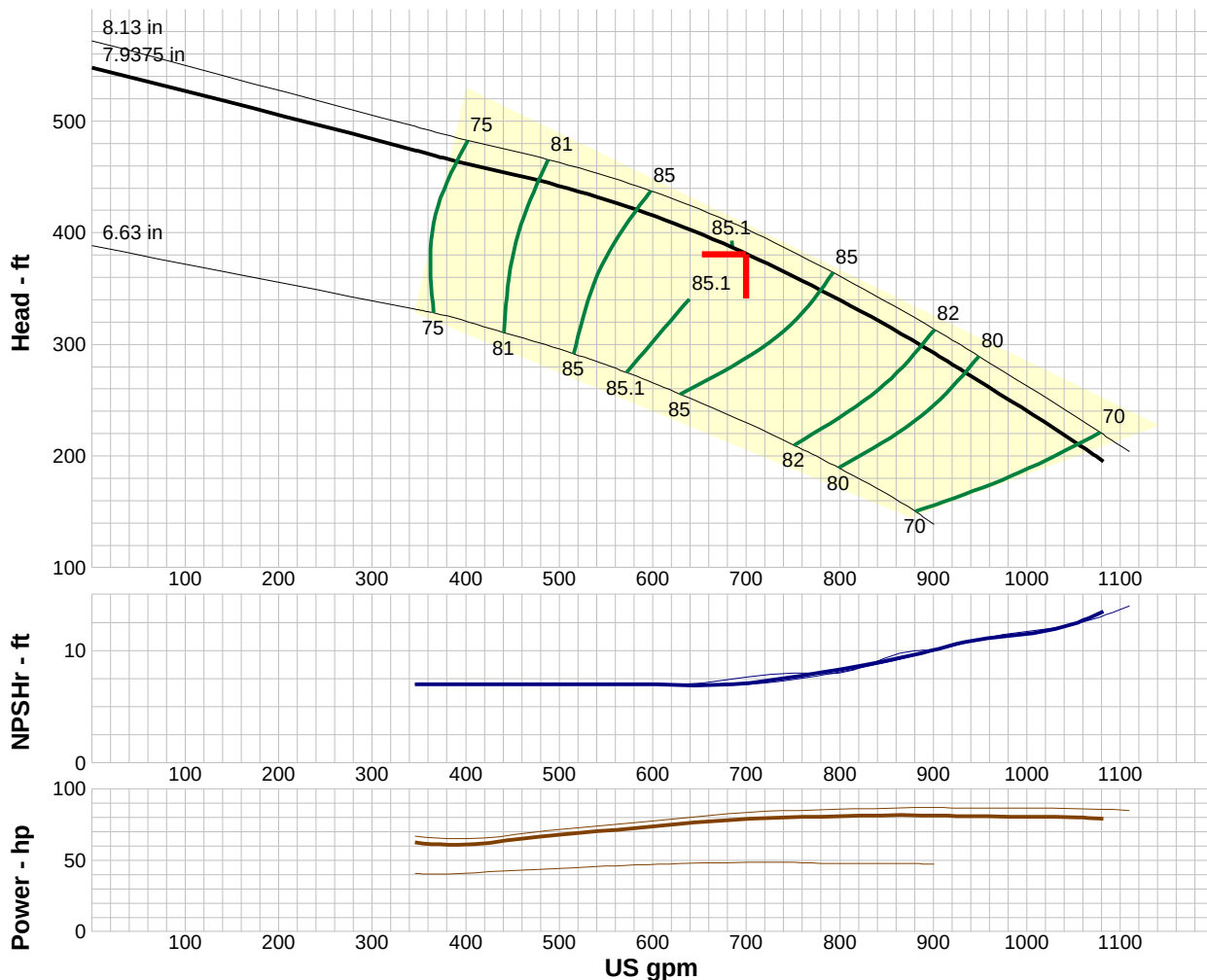
Temperature: 120 °F
Sphere size: 0.68 in

Pressure: 380 psi g

--- Data Point ---
Flow: 700 US gpm
Head: 380 ft
Eff: 85.1%
Power: 78.9 hp
NPSHr: 7.17 ft

-- Design Curve --
Shutoff Head: 548 ft
Shutoff dP: 237 psi
Min Flow: --- US gpm
BEP: 85.1% eff
@ 685 US gpm
NOL Pwr: 81.6 hp
@ 887 US gpm

-- Max Curve --
Max Pwr: 87 hp
@ 901 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
840	1770	320	83.3	81.2	9.02
700	1770	380	85.1	78.9	7.17
560	1770	426	84.2	71.4	7
420	1770	458	77.1	62.8	7
280	1770	---	---	---	---

APPENDIX C – FIRE FLOW CALIBRATION DETAILS

Table A Fire Flow Calibration Summary Table
Water Distribution System Master Plan
City of Cotati

Test Site	Flow (gpm)	Field Data			Model Results		Comparison			
		Static (psi)	Residual (psi)	Tank (feet)	Static (psi)	Residual (psi)	Pressure Difference (psi) ⁽¹⁾		Percent Error (%) ⁽²⁾	
							Static	Residual	Static	Residual
1	425 - 500	70.0	65.0	23.2	68.5	65.1	-1.5	+0.0	-2%	+0%
2	775	68.0	61.0	22.04	67.1	58.4	-0.9	-2.6	-1%	-4%
3	650 - 795	70.0	65.0	21.37	70.1	65.1	+0.1	+0.1	+0%	+0%
4	880 - 890	71.0	46.0	20.71	72.7	48.3	+1.7	+2.3	+2%	+5%
5	975 - 1000	75.0	56.0	20.06	74.6	58.0	-0.4	+2.0	0%	+4%
6	900	68.0	50.0	18.95	66.7	50.9	-1.3	+0.9	-2%	+2%
7	700	55.0	47.0	18.19	54.6	48.8	-0.4	+1.8	-1%	+4%
8	850 - 860	56.0	52.0	17.85	55.9	51.2	-0.1	-0.8	0%	-2%
9	700 - 760	47.0	40.0	17.21	47.9	40.0	+0.9	+0.0	+2%	+0%
Average							-0.2	+0.4	0%	+1%

Notes:

1. Pressure Difference = Model Pressure - Field Pressure.
2. Percent Error = (Model - Field) / Field x 100

